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Semisteel Shell Contracts Are Now Being Placed

Contracts for About One Million of These Projectiles Already Closed and Program Provides for Additional Million—Bids Are Asked for 1,100,000 Newton-Stokes Shells

WITH the constant expansion of the war program, the gray iron foundries are being accorded greater recognition. Aside from the tremendous tonnage of castings that has been placed with these shops throughout the country, for engines, for ships of all kinds and for building equipment for other essential needs, etc., the ordnance department is turning to the gray iron plants for aid in shell manufacture.

Contracts have been placed for approximately 1,000,000 semisteel shells with the American Radiator Co. for production at Buffalo; the United States Cast Iron Pipe & Foundry Co., for manufacture at Burlington, N. J., and with the Wilson Foundry & Machine Co., Pontiac, Mich. These shells average 100 pounds each and will require at least 35,000 tons of pig iron and 15,000 tons of steel scrap in their manufacture, assuming that a 30 per cent mixture is employed. The order for 1,000,000 cast shells represents only a comparatively small part of the immediate needs of the government and its allies. In the near future additional contracts for from 5,000,000 to 7,000,000 semisteel projectiles of varying sizes will be placed with the gray iron foundries and the ordnance program provides for further orders running into millions that probably will surpass the original estimate of 12,000,000 previously referred to in these columns.

Bids now are being received by the army ordnance department for 1,100,000 Newton-Stokes mortar shells which will be distributed among the gray iron foundries. One lot of 500,000 of this type of projectile was equally divided sometime ago among the following plants: Michigan Stove Co., Detroit; United States Radiator Co., Detroit; Foster Merriam & Co., Meriden, Conn.; Rathbone, Sard & Co., Albany, N. Y., and the Globe Stove & Range Co., Kokomo, Ind. All of these shops now are on a production basis.

Orders already have been placed with the gray iron foundries for more than 60,000,000 rifle and hand grenades. Four types of the hand grenade are being produced and these are being manufactured at the rate of 2,000,000 a month, and within the next four months this output will be doubled. Rifle grenades are being made at the rate of 1,000,000 monthly and this output will be multiplied appreciably in the next six months.

Announcement also has been made of the erection of a gun relining plant in France by the United States army ordnance department. It will be equipped to reline the heavy railway mount guns, from 8 to 16 inches, and will involve an expenditure of from $25,000,000 to $30,000,000. The machine tools required for this project will cost from $15,000,000 to $20,000,0000 and will embrace 218 units, including gun boring and engine lathes, rifling machines and grinders. Included in this equipment will be a planer,

How War Developments Affect Foundry Trade

Orders for approximately 1,000,000 semisteel shells have been placed by the ordnance department; additional contracts will be placed for 5,000,000 to 7,000,000 of these projectiles.

Bids are now being asked for 1,100,000 Newton-Stokes trench mortar shells. These are made of gray iron and this quantity is in addition to 500,000 now being produced.

Contracts for 60,000,000 rifle and hand grenades are now being executed by the foundries of the country. Production of hand grenades is at the rate of 2,000,000 a month and will be doubled. Rifle grenades are being made at the rate of 1,000,000 a month and this will be appreciably increased.

Large gun relining plant to be built in France will require 218 large machine tools. Total expenditure will be more than $25,000,000. A large tonnage of castings will be required for these tools.

Revision of priorities regulations fails to automatically classify foundry equipment—the basis for casting manufacture—notwithstanding that cast parts are required in the production of all kinds of essential equipment. Foundry equipment manufacturers have demanded automatic classification.

500 feet long, which will cost $450,000. For the building of these tools a tremendous tonnage of castings of all kinds will be required.

From the foregoing it is evident that the gray iron foundry industry is rapidly being placed on a war basis. Plants that have practically been thrown into idleness because of their non-essential production are being deluged with opportunities to engage in all kinds of war work. In addition, this involves a large amount of new foundry equipment of all kinds, since only a comparatively few shops are equipped to manufacture projectiles at the rate at which they are required to meet the needs of our government and its allies. To secure this equipment and to place it on a producing basis is a real task.

Probably the greatest problem confronting the pig iron procurement committee is that of obtaining an adequate supply of iron for these purposes. Original estimates of 500,000 tons are already being exceeded and a further tightening of shipments for nonessential needs is anticipated.

Large orders for railroad castings have been placed with the malleable foundries and the steel casting plants are crowded to capacity with government work of all kinds. Brass castings are used in the construction of practically all of the foregoing equipment and thousands of parts are being furnished by the die-casting manufacturers of the country.

Ask Automatic Rating for Foundry Equipment

WASHINGTON, D. C., Aug. 26.—Foundry equipment manufacturers are demanding an automatic classification of their product which was not accorded them in the revision of the priorities regulations as announced by the war industries board in circular No. 4, under date of July 1. These regulations define more specifically than any heretofore issued, the classes of materials for which no application is to be made for priority classification. It was pointed out by the makers of foundry equipment that their tools and devices form the basis for casting manufacture, affecting great economies in labor and thereby releasing additional manpower for the direct prosecution of the war. Furthermore, they state that castings are essential to the production of practically all the equipment given automatic classification and, therefore, they have petitioned the war industries board for an automatic classification.

It is doubtful, however, whether this will be granted because of the fact that when these regulations were revised it was not considered that this equipment was in sufficient general demand to warrant an automatic classification. In other words, the committee is of the opinion it has ample time to review all applications for priority ratings for iron, steel and other materials essential in the manufacture of foundry equipment. The system of automatic ratings was inaugurated chiefly to relieve the priorities committee of the tremendous burden of approving priority applications. It is said that the committee has reviewed more than 165,000 individual applications since the commencement of the priority system. Under the automatic plan it is expected that the number will be held at a greatly reduced minimum.

Government Will Aid

If the foundry trade needs special assistance to secure foundry equipment promptly in order that war and essential work may be carried on as ordered, that aid will be forthcoming from the government. The same assistance will be rendered foundry equipment manufacturers if they experience undue delays in securing material for their product ordered by foundries engaged in war and essential work. It is the opinion of the committee, however, that the present priorities status of these respective industries adequately takes care of their needs. Therefore, the foundry equipment industry is not liable to obtain a place on the automatic priorities list unless the manufacturers join the foundrymen and demonstrate conclusively to the priorities committee that such a rating is demanded imperatively to maintain essential production. It was pointed out that under the present automatic classification the priorities numbers given apply practically to foundry equipment on all work requiring castings in its construction.

For example, in the case of cranes which take B-1 classification, foundries furnishing castings for this equipment may use the same number to obtain foundry equipment and the manufacturers of the latter may do the same for their requirements. Similar series of the same priorities numbers prevail on other products given automatic classification into which castings enter, such as machine tools, textile machinery, locomotives, ships, railroad equipment or supplies, electrical machinery, oil well supplies, etc. If this automatic priority rating, as applied to foundry equipment for the purposes enumerated, does not obtain delivery as promptly as needed, both the foundry and the foundry equipment manufacturer may make special application for higher rating which will be passed upon by the committee in accordance with the individual circumstances.

Priorities Applications Limited

It is the interpretation of members of the committee, however, that the same automatic priority number, back to the foundry equipment shall not hold good for the war and navy departments and for the emergency fleet corporation which is given an A-5 rating in priorities circular No. 4. In these cases the foundry makes individual application for priority against the foundry equipment maker and the latter does the same for his supplies. All other castings and equipment of essential character not included in the purposes of the automatic list take C ratings.

It is evident that applications for priority on foundry equipment or by manufacturers of the latter for supplies, have been comparatively limited in number and no automatic rating therefore, was believed necessary. This also conveyed the impression that only a portion of the foundry industry is engaged on war or essential work and that the needs of this portion can readily be taken care of by the present system. In an investigation of this subject by a representative of THE FOUNDRY, who interviewed a large number of members and representatives of the priorities committee, reference also was made

to the diversified character of foundry work which militates against the possibility of automatic classification because of the difficulty of checking up war or essential castings for which foundry equipment must be obtained.

As previously pointed out all orders placed by the army, the navy, and emergency fleet corporation take a blanket classification of A-5. These orders, of course, are subject to a higher rating, particularly when the automatic classification would delay production or burden the manufacturer with numerous A-5 orders. In that event the contracting officer of one of the three federal departments would ask for speedier delivery and the priorities committee would consider the application. Individual manufacturers also may place automatic ratings on their own orders for materials, but only when those materials are for certain products. Affidavits stating the intended use and the priority classification covered must accompany each order for materials purchased. These automatic ratings have been determined by the priorities division and cover materials for the following articles:

For all turbines, A-4; locomotives for the railroads under federal control, A-4; electrodes, A-5; rope wire and wire rope, A-5; all water craft for the Emergency Fleet corporation, A-5; all other water craft, except pleasure, A-6; machine tools, for wood and metal, machinists' tools, small tools, hand tools, mining tools, and mining machinery and equipment, A-6; railroad materials, other than locomotives, for railroads under government control, B-1; locomotive cranes and traveling cranes; B-1; electrical equipment other than turbines, but not supplies as distinguished from equipment, B-2; farm implements, B-2; textile machinery, B-2; tools, implements, machinery, B-2; tools, implements, machinery, and equipment required for producing, harvesting, distributing, milling, canning, and refining foods and feeds, B-2; binder twine and rope, B-2; and oil well supplies and equipment, for producing petroleum and gas, but not including pipe lines, storage tanks of 1000 barrels or more capacity, tank cars or refineries, B-2; for operation and maintenance of coke oven plants, mines, smelters, furnaces, rolling mills, wire drawing mills, pipe and tube mills, A-6; iron and steel chain, B-2; repair parts to shoe machinery and for operation and maintenance of shoe manufacturing plants, B-2; and maintenance of jobbers and fabricators iron and steel stocks, B-4.

Scrap Prices Regulated on Pacific Coast

NOTWITHSTANDING the establishment of government prices for foundry scrap, dealers on the Pacific coast have been asking and receiving greatly in excess of existing quotations. Several months ago the dealers in this section made an effort to have higher prices named for this section of the country than are prevailing elsewhere, but their request was refused by the committee on scrap iron and steel of the American Iron and Steel institute. It was contended by them that higher prices were necessary to bring out the material and in view of the greatly increased consumption of scrap by the Pacific coast foundries an acute shortage of this material existed.

The foundrymen, however, contended that the government prices were applicable equally to them as to other casting manufacturers more favorably located with reference to their scrap supply and recently they have made an agreement not to pay in excess of the government schedule. The foundrymen of California and Oregon made an adjustment some time ago and recently an agreement was reached between the Washington State Scrap Dealers' association and the Seattle Foundrymen's association. The scrap dealers were represented by a committee consisting of Frank Schwartz, chairman; M. Neider, Joseph Sussman, A. Krom and B. Kahan. The foundrymen's committee consisted of F. G. Frink, chairman; W. A. Letcher, W. R. Tomkins, John Hartman and G. B. Gimmel. This agreement is based upon the government schedule and its provisions follow:

First.—It is agreed that all trading in scrap iron shall be done only at prices not in excess of those fixed by the subcommittee on scrap iron and steel of the American Iron and Steel institute as approved by the President of the United States.

Second.—All cast iron scrap shall be classified into four grades as follows:

First grade shall consist of cast iron scrap of first quality which possesses evidence of having been machined, such as planed or turned surfaces, bored or drilled holes, etc, broken railroad car wheels conforming to the Master Car Builders' association's standards, building columns and agricultural scrap all to be broken to cupola size, no piece to exceed 150 pounds in weight. Maximum price to be $34 per gross ton.

Second grade shall consist of miscellaneous cast iron car wheels not included in the first grade building castings such as post caps, bases and lintels, municipal scrap, such as street water and gas main castings, journal boxes and plain cars and railroad castings not machined, cast iron radiators and soil pipe and soil pipe fittings, bridge and structural castings and other plain gray iron castings not machined or not showing a white or mottled fracture when broken or elsewhere mentioned in these classifications. All above to be broken to cupola size. Maximum price to be $32.50 per gross ton.

Third grade shall consist of brake shoes, bridge washers and separators. Maximum price, $29 per gross ton.

Fourth grade shall consist of cleaned stove plate free from malleable iron and steel part grates, burnt iron or other miscellaneous scrap usually collected with this material. Maximum price, $28 per gross ton.

Third.—It is agreed that should scrap for any above classifications be not broken to cupola size the maximum price shall be $5 per gross ton less than above schedule.

Fourth.—It is agreed that the foundrymen will pay not to exceed the above maximum prices only to recognized dealers whose lists of names are hereto attached or who may be added to list from time to time by joint committee of Seattle Foundrymen's association and Washington State Scrap Iron Dealers' association and railroad or other industries controlled or operated by the United States government.

Fifth.—All prices are to be f.o.b. car consumers' spur, track or at consumers' usual point of receiving scrap. All charges, including war tax, to be paid by the seller. Inspections to be performed by purchaser and all expenses incident to rejection to be borne by seller. All rejected material to be solely at the disposal of the seller, after written notice of rejection.

Sixth.—This agreement to go into effect immediately and is to remain in force while prices are regulated by the United States government. These prices are maximum and are to be changed from time to time as maximum prices are changed by the government.

Making Cast Steel Wheels for U. S. Army Trucks

How The Dayton Steel Foundry Co. Has Met the Demands of the Government for Increased Output and How the Capacity of the Plant Was Increased Without Interrupting Operation

PRIOR to 1914 the establishment of a new manufacturing enterprise was a comparatively deliberate procedure. Plans were prepared, contracts were let, the plant was constructed and production was commenced. In a few rare cases the sales organization was set up slightly in advance of the completion of the plant and some accumulation of orders awaited the first shipments to be made. However, since the advent of the war this procedure has been radically changed.

The Dayton Steel Foundry Co., Dayton, O., presents a typical instance of the unexampled pressure which the war has placed on many manufacturing plants, and the way in which the customary process involving new construction has been revolutionized. Here an existing plant with a commodity urgently needed has carried on production coincident with plant extension. Manufacturing problems of a pioneer character have been complicated by industrial growing pains. This company has met the situation by applying the most modern methods of foundry operations and by adapting its facilities to new conditions. During the years in which this plant had developed normally, it had supplanted crucible steel with converter steel and finally had installed a 1-ton Snyder electric furnace. Recently a 3-ton electric furnace was added, giving a steel capacity of about 75 tons per day at the present rate of operation. The Dayton company developed a hollow steel truck wheel which was manufactured commercially prior to the war. When the government board of engineers designed the army motor truck the type of wheel manufactured by this foundry was analyzed and many of its features were embodied in the standard design. By reason of this fact the company entered at once upon the production of both front and rear wheels for the class B army truck, and also the standard wheel for 155-millimeter guns. This necessitated hurried alterations to existing facilities, and the addition of a large amount of added equipment. Shop methods were altered to get quantity production, and new construction work was carried along simultaneously with the manufacture of the wheels. In fact, at the present time, storage yards, a sand house, and some extensions are being built, and a number of contracts for small castings for commercial lines are being completed while 24-hour operation obtains in truck wheel manufacture for government service.

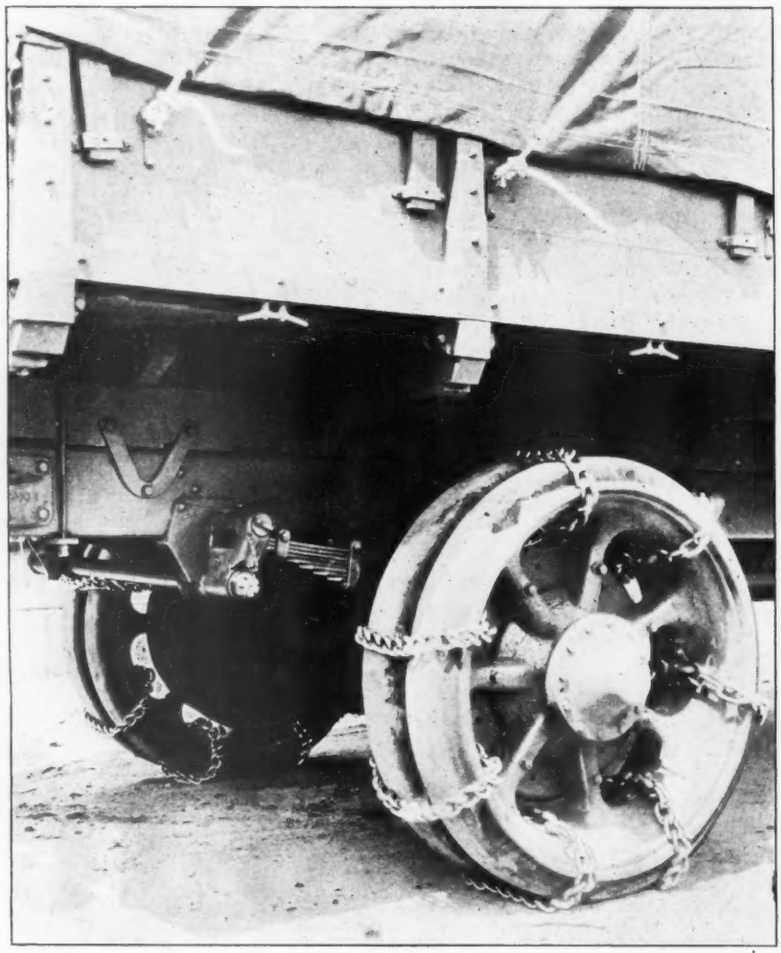


FIG. 1—GREAT WEIGHT AND REPEATED DRIVING STRAINS DEMAND STURDINESS IN ARMY TRUCK WHEELS

The plant as it is today, is shown in Fig. 2. As may be noted, the arrangement is compact to a degree which assures a minimum handling of materials during the progress through the various operations. The main building contains under one roof the pattern, molding, melting, pouring and cleaning departments. Except for shaking out, which requires a small amount of lost motion due to lack of space at the present time, every operation is in regular sequence and marks a step in the advance through the foundry.

The patterns are all made on the second floor over the east bay at the front of the main building. The shop is light, well ventilated and is separated entirely from the foundry floor. The machine equipment includes two wood turning lathes which will handle patterns up to 4½ feet in diameter, band saws, a disc grinder, jointer, 16-inch engine lathe, drill press, shaper and trimmer. Patterns are completed and assembled on match boards, and are then delivered to the pattern storage until needed. The pattern storage is separated from the shop by about 100 feet, and was constructed after the foundry was completed. This subsequent construction prevented a layout which would permit the patterns to be handled directly to storage. However, a bridge will be constructed and the patterns will be transferred across on trucks to the storage racks. An elevator will be installed to carry the patterns from storage to the molding floor. A complete record is kept of all patterns. These are stored on racks constructed of steel pipe with galvanized shelves, numbered to accord

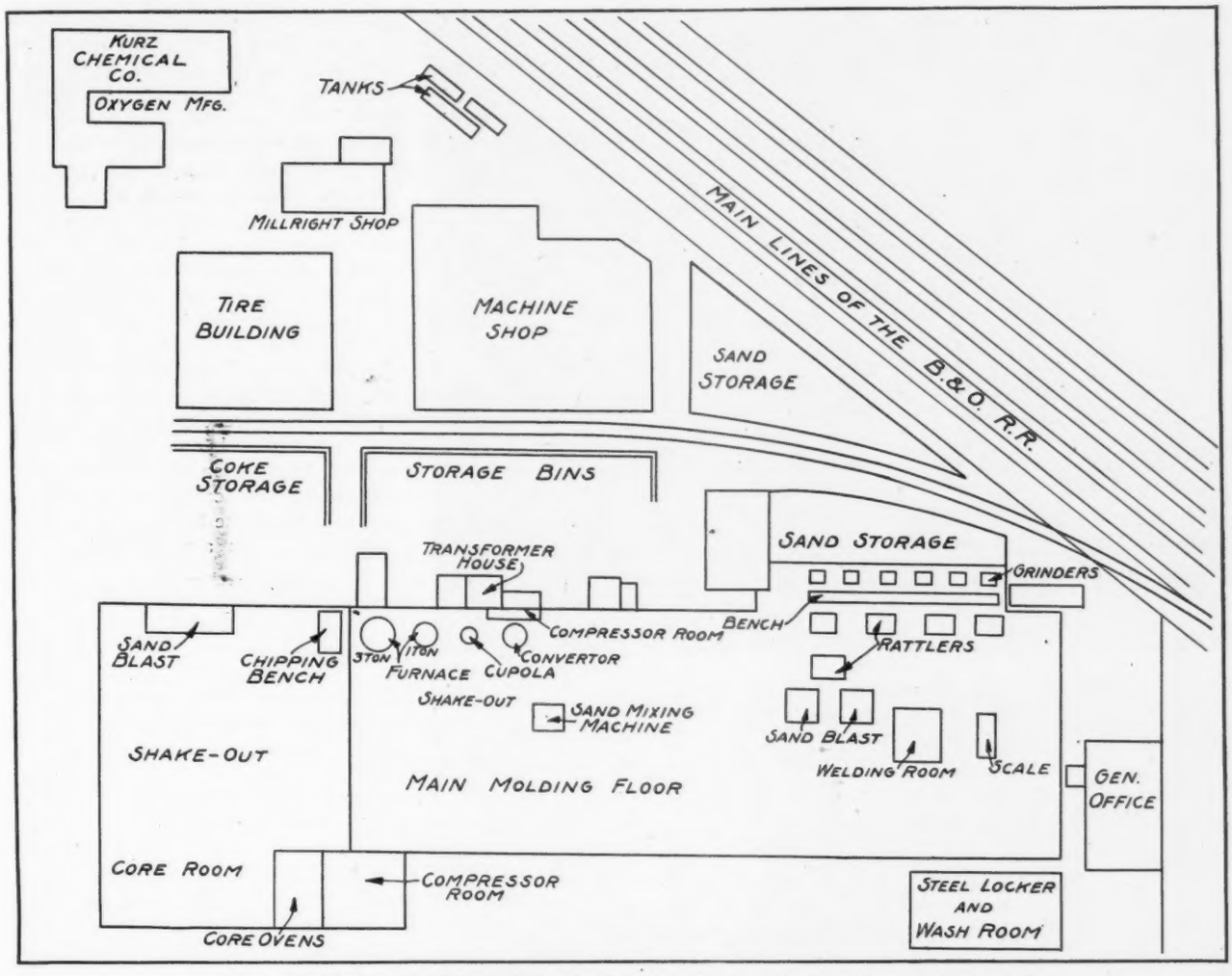


FIG. 2—GENERAL ARRANGEMENT OF THE DAYTON STEEL FOUNDRY CO.'S PLANT

with the record system which is in use.

The core room adjoins the main foundry floor in a unit which constitutes a part of one of the side bays. Four roll-over core machines are provided for the wheel cores, while the lighter cores for other castings produced by this foundry are made by hand on benches. The core machines were furnished by the Cleveland Osborn Mfg. Co., Cleveland. Sixty men are employed in this department, and make not only all the cores required for the production of the truck and artillery wheels, but also a large variety of small cores for the miscellaneous castings previously mentioned. Immediately after molding, the cores are placed on racks within convenient reach of the benches and machines. These racks are shown near the door of the core ovens in Fig. 8 The ovens are of the car type manufactured by the W. W. Sly Mfg. Co., Cleveland, with a capacity of four cars. The ovens were originally served by wide-gage tracks, upon which the cars were operated and handled through switches to their stations at the benches. An interesting innovation is provided by the present method of handling the cars, or more properly racks, as no wheels are necessary as they are now operated. A concrete floor was constructed over the entire core room and on the same level within the ovens. The racks are mounted rigidly upon steel angle legs riveted to each of the four corners. Thus when loaded at the benches, or when inside the ovens, the racks are stationary and upon a solid base. A number of hand trucks provided by the Stuebing Truck Co., Cincinnati, are used to move the racks. These trucks may be pushed under the frames and elevated through the lever action of the steering handle so that the racks are swung clear and may be moved to any point desired. Stationary shelves at the side of all molding floors provide convenient storage for the cores after they are removed from the ovens.

Main Molding Floor

The main aisle of the molding floor, extending the full length of the building, is devoted to the production of the three types of steel wheels. These are the single tire front and dual tire rear wheels for the class B army truck, shown in Fig. 10, and a larger double rim gun carriage wheel for the 155-millimeter field pieces, Fig. 11. The entire output of wheels at the present time averages about 190 per day of 24 hours, and all operations from the raw material to the completed, camouflaged or painted wheel with the tires mounted are performed within the plant enclosure.

The accompanying illustrations, Figs. 3, 4 and 5, show the main molding floor. The molds are made in steel flasks consisting of only a cope and drag. These flasks are machined to jigs so that they are interchangeable and any cope will fit any drag. This permits the molders to accumulate a number of drag molds ahead which may be cored and finished during the production of the copes.

All ramming is done on heavy jolt-ramming, roll-over machines. Three of these were furnished by the Cleveland Osborn Mfg. Co., Cleveland, and one by the American Molding Machine Co., Terre Haute, Ind. In addition, there are three large, plain jolt-ramming machines for supplementary work. The drag pattern is mounted on a match-plate to which the flask is fastened firmly by wing nuts. The match-plate in turn is fastened to the table of the ramming machine, as shown in Fig. 5.

FIG. 3—SECTION OF THE MAIN MOLDING FLOOR SHOWING THE 3-TON ELECTRIC FURNACE WITH THE TOP REMOVED FOR RELINING
FIG. 4—GENERAL VIEW OF THE MAIN AISLE AND ONE SIDE BAY
FIG. 5—LARGE ELECTRIC FURNACE AND ONE OF THE RAMMING MACHINES

The entire pouring floor is paved with concrete. This makes possible the use of the elevating and conveying hand trucks in moving the molds to the desired positions. The trucks used are similar to those employed in handling the core racks, except that they are smaller. The completed mold is removed from the roll-over machine to the pouring floor in this manner. The molds are skin-dried by crude oil atomizers which may be quickly adjusted to the air hose lines placed conveniently at intervals for use in blowing dirt from the molds. The hollow rim and spokes are attained by seven core segments, each of two sections pasted together. These are placed on chaplets in the finished drag section of the mold. After closing-over the copes, the molds are poured through the hubs and four risers and liberal vents are provided.

Handling Equipment

The flasks are handled and placed on the molding machines by either pneumatic or electric jib cranes. Seven cranes are attached to columns at intervals along the main aisle. Pouring ladles, finished castings and repair parts for the furnaces and converter are transferred by three 5-ton overhead bridge cranes the runways for which are supported on the columns along the main floor. Two of these cranes were built by the Northern Engineering Works, Detroit, and the third was furnished by the Case Crane & Engineering Co., Columbus, O. The finished castings are shaken-out by these cranes, and the flasks are returned within reach of the jib cranes. The use of the lifting hand trucks on the concrete floor saves a great deal of crane time and also prevents congestion which from the volume of work handled on the one floor, would constitute a serious factor of delay. The castings are shaken-out at a point adjacent to the sand-mixing machine. This constitutes the one feature of inconvenience in the entire molding sequence. It is necessary to bring the flasks, after pouring, from either side to the center of the main building and after shaking-out the castings to return them to their respective piles near the ramming machines. After shaking-out, the castings are delivered to the cleaning department. The side bays contain 25 jolt and squeeze machines for making molds for small motor frames and automobile castings.

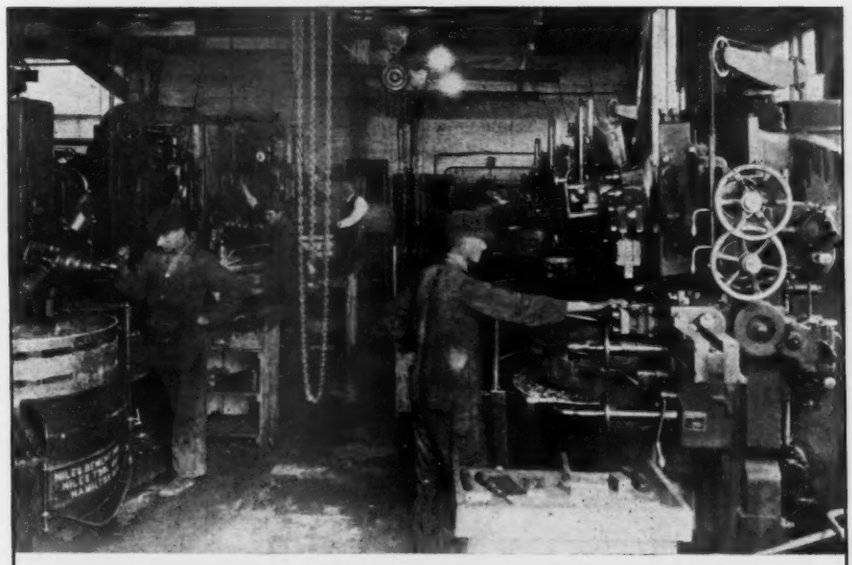
As previously stated, the steelmaking equipment has been expanded to meet the present demands. A 2-ton bessemer converter, served by a 54-inch cupola which provides about 36 tons of metal per day, was the first unit installed. This converter is still in continuous operation, producing from 12 to 15 heats a day. It forms a valuable adjunct to the electric furnaces later put

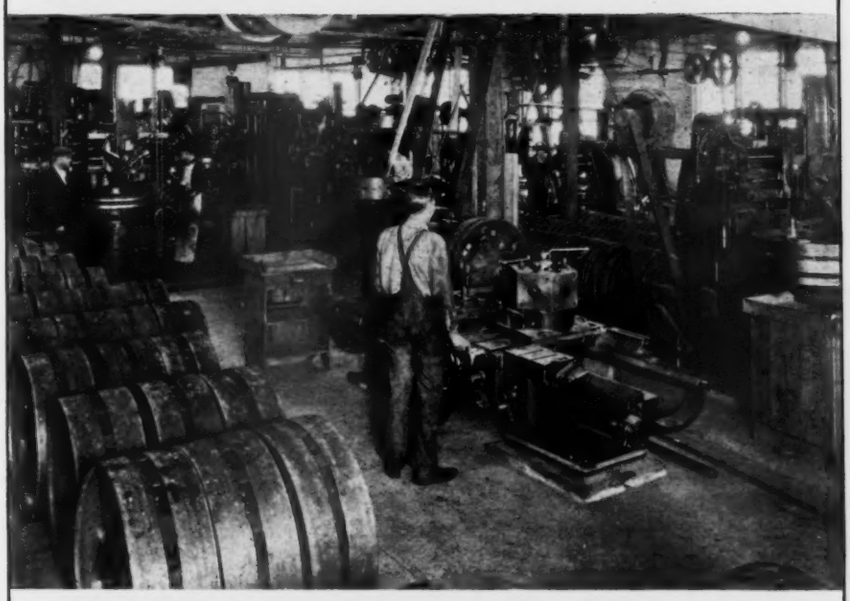
in service. These consist of 1-ton and 3-ton units respectively, each built by the Industrial Electric Furnace Co., Chicago. Both are of the rocker type, melt from a cold charge and utilize the charge as one contact of the arc. The smaller furnace is charged through the side, and has a single, 4-inch carbon electrode which is regulated and advanced by hand. Although maximum economy is not obtained in either furnace at the present time, the smaller furnace is operating on a 60 per cent power factor at 600 kilowatts on a 250 open circuit voltage. The best output up to the present has been 14 heats of 2000 pounds each, with cold charges melted in 24 hours and 40 minutes. The average number of heats is 12 per day or about two hours melting time on each charge.

Larger Furnace is Complete

The 3-ton furnace has many points of superiority over the smaller one. As may be noted from Fig. 3, the entire top may be swung back to allow the charge to be placed directly in the furnace, and a tight closure prevents excessive emission of gases after it is closed. A three-phase, open-circuit voltage of 175 is used, and a power factor of 75 per cent with a 1690-kilowatt load is obtained. This will be improved when certain changes in operating conditions have been effected. A charge of 4500 pounds of cold scrap is made, and the melting time is practically the same as in the smaller furnace. Two 5⅛-inch electrodes are automatically controlled, and a marked electrode economy has developed since this automatic control was established. The smaller furnace uses about a ton per month of electrodes, and the 3-ton furnaces use slightly less than 3 tons per month. The breakage is more marked in the smaller furnace due to hand control. The continuous operation of these furnaces requires a force of 21 men, divided in three shifts, but economy in labor is secured through having two similar furnaces placed adjacent, as in this case. The furnaces are never allowed to cool except for necessary repairs.

Interesting problems have been encountered in connection with the electric furnace practice at this foundry. As scrap is used exclusively the changing conditions in the scrap market have had a marked effect. Shortage in car springs and many commercial grades of light scrap have forced the use of bulky bloom and billet croppings, car couplings and similar material together with the light turnings and punchings. The heavier material, due to the large area of unexposed surface, unsuitable for cupola melting, has been found readily available to the electric furnace. Compressed scrap, and the miscellane-





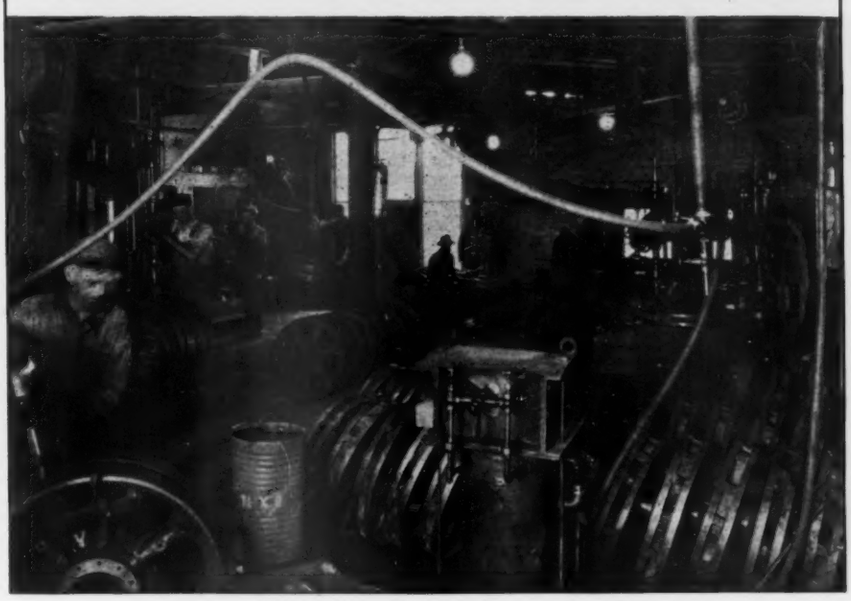


FIG. 6—BATTERY OF VERTICAL TURRET LATHES USED FOR THE VARIOUS MACHINING OPERATIONS ON THE WHEEL HUBS
FIG. 7—GENERAL VIEW OF THE MACHINE SHOP SHOWING THE LATHES
FIG. 8—BORING THE RIMS AND RIVETING THE SEVEN SKID CHAIN LUGS

FIG. 9—A PORTION OF THE CORE ROOM WITH THE OVENS IN THE BACKGROUND—ONE OF THE FOUR CORE MACHINES IS SHOWN AT THE RIGHT IN THE REAR

ous trimmings from *tin hats,* deep sea mines, and aerial bombs have proved to be exceptionally well adapted to this method of making steel, and good analyses have characterized their use.

Bottom-pour ladles are employed to handle the metal from the electric furnaces as well as from the converter, and either one of the three traveling cranes is used in pouring. The capacity of all the melting units is about 75 tons per day, of which a portion is used for small castings which are molded and poured in each of the two side bays. The metal in this case is poured from hand ladles.

When the castings are shaken-out, they are removed by cranes to the extreme north end of the main aisle, where the gates and risers are removed by the oxyacetylene torch. If any minor defect is to be remedied, the wheels are removed to a room adjacent to the main floor, where the necessary repairs are made by an electric welding apparatus furnished by the Lincoln-Electric Co., Cleveland. The castings are then delivered to the cleaning department which adjoins and is connected with the main building.

Cleaning Equipment

The cleaning department is provided with two swinging grinders, furnished by the Pittsburgh Emery Wheel Co., Pittsburgh; four stand grinders, furnished by the Bunental Brothers, Dayton, and four electric aerial grinders constructed by the Standard Electric Tool Co., Cincinnati. The bonus system of payment has proved satisfactory in the grinding department. A few years ago, when smaller work predominated in the Dayton foundry, 14 grinders were in day and night operation, and often the end of the week found the bins piled with castings awaiting grinding. The bonus system was adopted, and at the present time, four men are handling all the grinding of small castings, with an increased output. Payment is made on a basis determined by weighing a quantity of castings of one type both before and after grinding, so that the amount of metal removed may be established for each class of casting.

The final cleaning on the wheel castings is accomplished by sand-blasting. The sand-blast equipment includes six hose type units, four of which were furnished by the W. W. Sly Mfg. Co., Cleveland, and two by the Pangborn Corp., Hagerstown, Md. One barrel type sand-blast, installed by the American Foundry Equipment Co., Cleveland, is also used. Compressed air for the sand-blast installations is furnished by three compressors; the first is a compound, electric-motor-driven machine manufactured by the Sullivan Machinery Co., Chicago. It is operated by a 100-horsepower General Electric motor and delivers 775 cubic feet of air per minute. The other unit is a compound compressor driven by a 125-horsepower motor, which delivers 770 cubic feet of air per minute. It was furnished by the Platt Iron Works, Dayton, O. The third compressor is driven by a 40-horsepower motor and delivers 175 cubic feet of air per minute. Air lines are laid throughout the foundry so that connections are available at all the benches, and at intervals about the floor. Short hose lengths fitted with nozzles deliver air under pressure for dusting out and blacking, and spray atomizers, burning heavy oil, may readily be attached for skin-drying molds. Two positive-pressure blowers, manufactured by P. H. & F. M. Roots Co., Connersville, Ind., furnish the blast for the converter and cupola.

Annealing the Wheels

After sand-blasting, the wheels are carefully annealed. The two annealing furnaces are each of the car type. One is built over a pit to provide ease in loading the cars, as the wheels are rolled directly from the sand-blast rooms to the annealing cars. The furnaces are provided with both gas and oil lines, although gas is used exclusively. The temperature is indicated by four thermo-couples placed in each furnace with recording dials in the chemical laboratory. These were furnished by the Brown Instrument Co., Philadelphia, a complete physical and chemical laboratory is maintained,

FIG. 10—THE FINISHED TRUCK WHEELS READY FOR THE HUB LINERS, CAPS AND TIRES—NOTE THE MACHINE WORK REQUIRED IN FINISHING THE HUBS AND RIMS

and the anneal is carefully governed according to the chemical analyses of the casts, although the chemical specifications for the wheels are not obligatory. The company is governed entirely by the physical tests in the acceptance of the wheels, and by a minute inspection of the outward characteristics of each casting.

The next step in the manufacture necessitated a complete machine shop capable of handling the entire foundry output. This shop, which was laid out by Chief Engineer P. W. Klinger, is an example of compact efficiency. The machining operations required include boring the hub, machining the rims, boring and tapping holes in the hub and in the spokes, and boring 14 holes in the center line of the felloe for the attachment of skid chain lugs. Vertical turret lathes are used for the operations on the hubs. The shop equipment includes three vertical turret lathes, furnished by the Niles-Bement-Pond Co., New York, installed by the Bullard Machine Tool Co., Bridgeport, Conn., and one by the Gisholt Machine Co. These boring mills have complete cutting lubrication and average 100 feet per minute cutting speed for 24-hour operation. The lighter wheels are machined on four lathes, furnished by the R. K. LeBlond Machine Tool Co., Cincinnati. The holes for the hub plates and also for the brake drums on the rear wheels are drilled simultaneously on a 21-spindle drill built by the National Automatic Tool Co., Richmond, Ind. These holes are reamed and tapped on radial drills, two of which were furnished by the Morris Machine Tool Co., Cincinnati, one by the Cincinnati Bickford Tool Co., Cincinnati, and one by Canedy-Ott Mfg. Co., Chicago Heights, Ill. The holes in the felloe are drilled on a vertical press. The chain lugs are each held in place by two rivets, which are set by means of a pneumatic riveting gun. The physical laboratory has a band saw for cutting coupons, a lathe for turning test bars, and a drill press, which is used to take drillings for the chemical laboratory. Chemists check all heats taken during the 24-hour operation of the melting units.

Finishing the Wheels

After final machining, the wheels are rolled into the finishing shop. Air brush equipment is used to spray on the paint at this stage, the truck wheels receiving a coat of the khaki color to match the trucks with which they are later assembled. The gun carriage wheels are camouflaged in a like manner, four or five different colors being used from different containers which may be instantly attached to the atomizing device. This method of camouflage was developed by the Dayton Steel Foundry Co., and has met with favor due to the ease with which the different colors are blended. The tires are next forced on and bronze hub liners and caps are added. The press used to set the tires is a 265-ton hydraulic machine manufactured by Charles F. Elms Engineering Works, Chicago. A steel hoop is forced into the slot between the two halves of the double rim on the rear wheels to form a divider for the double rubber tires.

The completed wheels are stored until shipment in a separate warehouse, and an ingenious arrangement of a pneumatic lift actuating a simple elevator platform, is used to hoist the

FIG. 11 — THE WHEEL FOR THE 155-MILLIMETER GUN IS EXCEPTIONALLY STURDY AND WELL - PROPORTIONED

wheels into the freight cars for shipment. At every point throughout the finishing from the time the gates and risers were knocked off, the wheels are transferred from one operation to the next by rolling.

Several features of interest contribute to the self-contained and complete character of this plant. When oxyacetylene was adopted for cutting and trimming the castings, a complete acetylene plant was installed. The other necessary ingredient is furnished by an oxygen plant located within the foundry enclosure and owned in part by members of the Dayton company. This plant produces oxygen for commercial purposes and supplies all that is needed in the foundry. A sand house capable of holding the entire winter's supply of sand has been constructed and bins are being built to confine the scrap piles and to permit of the storage of a larger amount within a minimum of space.

George and Jacob Walther, brothers, started the plant as a crucible steel foundry in 1906. In 1911 the 2-ton converter was added. The crucible shop was discontinued in 1913 and about this time the Dayton Steel Foundry Co. was organized with George Walther president; Jacob Walther, general manager, and W. A. Pierce, secretary-treasurer. The first electric furnace was installed in 1916, and with the growth of the steel requirements incident to the wheel manufacture, the second and larger furnace was added this year.

Pattern Shop Proprietors to Organize National Association

The first general meeting of the Interstate Patternmakers' Association was held at the Hotel Winton, Cleveland, recently. The question of effecting an affiliation with the National Employers of Patternmakers was considered at length and it was decided to meet with this organization at its annual convention in September when a national association of pattern shop proprietors will be organized. A resolution was adopted favoring the enactment of laws by the national government for the creation of employment bureaus in various districts for the purpose of facilitating the control and distribution of all kinds of skilled labor during the period of the war.

Officers of the Interstate Association were re-elected as follows: E. F. Ball, president, Newark Stamping & Foundry Co., Newark, O.; Max A. Silz, vice president, Superior Pattern Works Co., Cleveland, and T. T. McGuire, secretary-treasurer, Columbus, O. In addition to the officers the following constitute the board of directors: E. O. Melvin, Melvin Bros., Columbus, O.; A. E. Schuchert, A. E. Schuchert Pattern Works, Cincinnati; Charles D. Smith, Morner & Smith, Dayton, O. and J. H. Bridge, Maumee Pattern Co., Toledo, O.

Utilizing Copper Alloy Scrap

The manufacturers of nickel-copper-zinc alloys in Great Britain were cut off from their supplies of copper about two years ago. As a result, the entire trade in plated ware with a nickel silver base would have come to a standstill if some expedient had not been adopted. It was found possible to utilize the scrap produced in the production of cupro-nickel for war needs, and the great demand for this alloy is illustrated by the fact that the scrap production has been ample as raw material for the needs of the electro-plating trade of the kingdom. The government took over the distribution of the scrap, and fixed the price higher than its market value. The difference between its value and the fixed price represented a contribution to the nation's finances.

Tests Uncover Domestic French Sand Substitute

Thorough Investigation Conducted With Different Molding Sands Shows Zanesville Product as Closely Approaching French Sand in Desirable Qualities

By C P Karr

THE growing scarcity and consequently increased cost of fine French molding sand used as a facing sand in both the ferrous and nonferrous metal foundries stimulated the desire to find in this country a facing sand equal to the imported French sand. To make the proper comparisons it was necessary to investigate the imported French sand and ascertain its properties as a molding sand. It was submitted to a mechanical analysis, and determinations were made of its specific gravity, moisture content, melting point and tensile strength. In the last tests, the amount of water used in tempering the sand, the temperature at which the briquettes were molded, and the drying time were varied and noted. The method of ramming the molds and the exposure to dampness were kept as uniform as possible.

The sands studied were fine French imported molding sand; a fine grained sand from Zanesville, O., furnished by L. K. Brown; a No. 000 Albany sand, furnished by the J. W. Paxson Co., Philadelphia; and a No. 3 North river sand furnished by Whitehead Bros., New York. It is hoped to add the Windsor Locks fine facing sand to this group before the investigations are completed.

The important requisites of a fine facing sand are a high melting point, a fine texture, which is best expressed by the average grain size of the sand, a low moisture content, and a high tensile strength, which, in foundry parlance is expressed by the phrase —"a good bond." The grains of a facing sand are necessarily so fine, and the mass of the quartz particle is so small in relation to its area, as compared to the corresponding quantities of a regular molding sand that the value of a facing sand depends to a considerable extent upon its tensile strength. Upon this property depends its power to bond in with the molding sand with which it is placed in contact. The quartz particles of a fine facing sand are more uniform in grain size than the quartz particles in a coarser sand; furthermore, on account of the fact that the ratio of the depth of the facing to the depth of the backing is negligible, permeability and porosity are properties which are not of so much importance in a facing sand as in a general molding sand.

With two exceptions the Zanesville sand shows increased tensile strength as the amount of water used in the

From a paper presented before the American Foundrymen's association. The author, C. P. Karr, is associate physicist, bureau of standards, Washington.

Tests of Molding Sands

MOLDING SAND TESTS FOR FINENESS

SIEVE ANALYSIS

Sieve mesh and size of opening—Per cent passing each sieve

	200 .074 mm .0029 inch	150 .104 mm .0041 inch	100 .147 mm .0058 inch	65 .208 mm .0082 inch	48 .295 mm .0116 inch	35 .417 mm .0164 inch	28 .589 mm .0232 inch	20 .833 mm .0328 inch	Aver. mesh fineness	Specific gravity	Moisture content %	Melt'g point Cent.
Zanesville, O....	55.3	83.8	92.9	96.5	98.2	99.8	100.0	.....	185	2.68	3.3	1580
Imported French.	55.8	74.8	88.8	96.1	98.8	99.5	99.8	100.0	170	2.63	1.0	1650
No. 000 Albany	31.0	49.4	75.2	94.2	98.1	99.0	99.6	100.0	86	2.64	0.6	1570
No. 3 No. River.	5.6	6.6	13.3	23.4	39.5	66.2	89.0	98.6	56	2.62	0.8	1550

Note.—Material was dried out in oven at 105 degrees Cent. All determinations made on material after drying. Average grain size according to W. S. Tyler screen scale.

TENSILE TESTS OF FINE MOLDING SANDS

ZANESVILLE, OHIO, SAND

Water, per cent	Temp. Cent.	Hours	No. of briquettes	Lbs. per sq. in. average	Remarks
12.0	21.0	48	2	7.38	Dried in oven 48 hours at 105 degrees Cent. Sand pressed in molds 6 times on opposite sides. In damp closet, 24 hours. In air, 24 hours.
7.0	25.5	48	2	3.13	
10.0	20.0	48	2	2.75	
6.0	23.0	48	3	2.75	
16.0	23.5	48	2	2.00	
6.0	19.0	48	2	3.00	Rammed on one side only with thumb.
7.0	25.0	46	3	4.00	Rammed both sides with thumb
10.0	24.0	48	3	7.00	After 48 hours in damp closet.
21.5	24.0	48	2	13.00	Rammed both sides with thumb

IMPORTED FRENCH SAND

Water, per cent	Temp. Cent.	Hours	No. of briquettes	Lbs. per sq. in. average	Remarks
7.5	20.5	48	9	9.50	In damp closet 24 hours. In air 24 hours.
7.5	21.0	48	9	12.70	Sand and water mixed 3 min.
7.5	21.5	72	9	11.70	Molds pressed 6 times by hand on two opposite sides.
7.5	21.0	70	8	14.70	Sand dried out in oven 60 hours at 105 degrees Cent. Sieved through 14 mesh.

No. 000 ALBANY SAND

Water, per cent	Temp. Cent.	Hours	No. of briquettes	Lbs. per sq. in. average	Remarks
10.0	23.5	48	3	6.50	Molds pressed 6 times by hand on two opposite sides.
10.0	23.0	48	6	6.66	
7.0	22.0	48	2	3.00	

No. 3 NORTH RIVER SAND

Water, per cent	Temp. Cent.	Hours	No. of briquettes	Lbs. per sq. in. average	Remarks
7.5	23.0	48	6	4.70	Molds pressed 6 times by hand on two opposite sides.
7.5	20.5	48	6	3.12	
7.5	22.0	48	8	4.34	

mixing is increased. The specimens used were dried in an oven for 48 hours. In some of the experiments with French sand the specimens which were oven-dried for 70 to 72 hours, showed an increased tensile strength over similar specimens dried for a shorter period of time. The No. 3 North river sand represents the average molding sand and the tests show what may be expected of it. The No. 000 Albany represents the finer grades of Albany sand and is used for facings for large castings that require a smooth finish. The sand that most closely approaches the French sand in its desirable qualities is the Zanesville sand. This sand is more uniformly fine and of smaller grain than the French sand, which has a higher melting point, less moisture content, and a greater tensile strength.

The author is indebted to W. H. Sligh for making the tensile tests and the mechanical analyses of the various sands, to C. O. Fairchild for the determination of the melting points, and to the several firms who have kindly placed samples at the disposal of the bureau for analysis.

Making Basic Electric Furnace Bottoms

By A Walter Lorenz

OF ALL the difficulties attending the use of the electric furnace in the manufacture of basic steel for castings, the greatest is experienced in securing a substantial bottom. Probably 90 per cent of the trouble with basic electric steel is due to bad bottom, and this trouble seems to be the greatest problem of the inexperienced in the business .

Some approach the problem from the standpoint of open-hearth practice. The experienced open-hearth melter is especially prone to place a regulation basic open-hearth bottom in his new electric furnace, which is not good practice. Open-hearth melting is conducted under oxidizing influences, and, therefore, a fair amount of oxidizing material in the bottom does little harm, since it is no worse that the conditions surrounding it. Electric furnace practice, however, is mostly neutral or reducing, and to secure the full benefit of these advantages, the bottom itself should be as nonoxidizing as possible. Oxide in the bottom is just as active as oxide in the slag. In fact, the man who has had experience with the bottom *coming up* will think it is more so.

Keep Down Iron Oxide

Of course, it is impossible to make a bottom free from iron oxide, as even the best magnesite contains considerable of this impurity. But, we can keep the percentage of oxide down by a judicious choice of the bonding material which is necessary to set the magnesite. Instead of using basic open-hearth slag (containing considerable iron oxide) in the usual proportions of one part slag to four parts magnesite, it would be better to use blast furnace slag which is quite low in iron oxide. Its bonding power lies in its high percentage of alumina and silica, and since these are stronger bonding materials than iron oxide, less bond is needed, so that blast furnace slag may be used in the proportion of 1 to 10. Alkali salts, such as sodium silicate, should prove equally satisfactory. Such bonding material is highly fusible and, therefore, should be used sparingly, as a small quantity will perform the same function as a large amount of slag. Caustic soda or its salts may be dissolved readily in water, and in this condition may be mixed with the magnesite more thoroughly than is possible with any dry bonding material.

Rammming the Bottom

In making bottom, the refractory mixture, slightly moistened, should be rammed well in layers an inch or so in thickness. After ramming each layer, it should be thoroughly burned-in or set before putting down the next layer, in this respect following closely along the lines of open-hearth practice.

Electric arc furnace operators have always felt that these furnaces have a great advantage over any other type, either open-hearth or electric in the burning of the bottom, since it is such a simple matter to cover the bottom of an arc furnace with coke and raise it to a white heat in a comparatively short time. Notwithstanding the extreme simplicity of this method, it is wrong in principle.

In the first place, any iron oxide in the bottom will be reduced by the coke to metallic iron which will collect in small deposits reducing the strength of the bottom instead of increasing it. Moreover, to cover with coke a mass of basic material containing a fair proportion of lime, and then to raise this mass of coke (in intimate contact with the lime) to incandescence by means of the electric arc is almost duplicating the method employed in the manufacture of calcium carbide, where a mixture of lime and coke or coal is piled around a carbon electrode and converted to carbide by the heat from the electric arc.

This reaction does not need the full heat of the electric arc as was formerly believed, to be the case. I begins at approximately 1500 degrees Cent. and proceeds rapidly at 1800 degrees. It has been found in samples of blast furnace slag by various investigators, proving conclusively that the electric arc is not necessary to its formation.

No one would say that a calcium carbide bottom is a good bottom. And yet, this is what we should expect to get to a certain degree at least, by following the foregoing practice and examination of many bottoms burned-in by this method shows that we actually do get it. The writer has seen portions of such an arc burned bottom which fell to powder on exposure to the air. This same trouble is experienced by many foundries. A basic electric furnace bottom invariably cracks and powders in a short time if the furnace lies idle. A bottom made of similar materials in a basic open-hearth furnace will remain unaffected for months. The reason must lie in the excessive reducing conditions which prevail when burning-in the electric furnace bottom by means of coke and the electric arc. To obviate this condition, we may suggest that electric furnace bottoms be burned-in with gas or powerful, portable oil burners, notwithstanding the increased labor and expense.

To sum up, it is probable that to secure the best results, a basic electric furnace bottom should contain as little oxidizing matter as possible and should be burned-in thoroughly with a nonreducing flame. Such a bottom should give ideal results for all general conditions.

New Zinc Base Alloy

A new zinc base alloy which is said to possess interesting properties is being marketed in this country by the Zelco Metal Co., Pennsylvania Building, Philadelphia. The new metal was first introduced in England, where it was invented about a year ago by F. S. Hodson. At the request of the department of fuses of the British Ministry of Munitions, Mr. Hodson who was in England in conection with fuse work, developed it as a result of research at the Lennox Research Laboratories, London. The new alloy successfully met

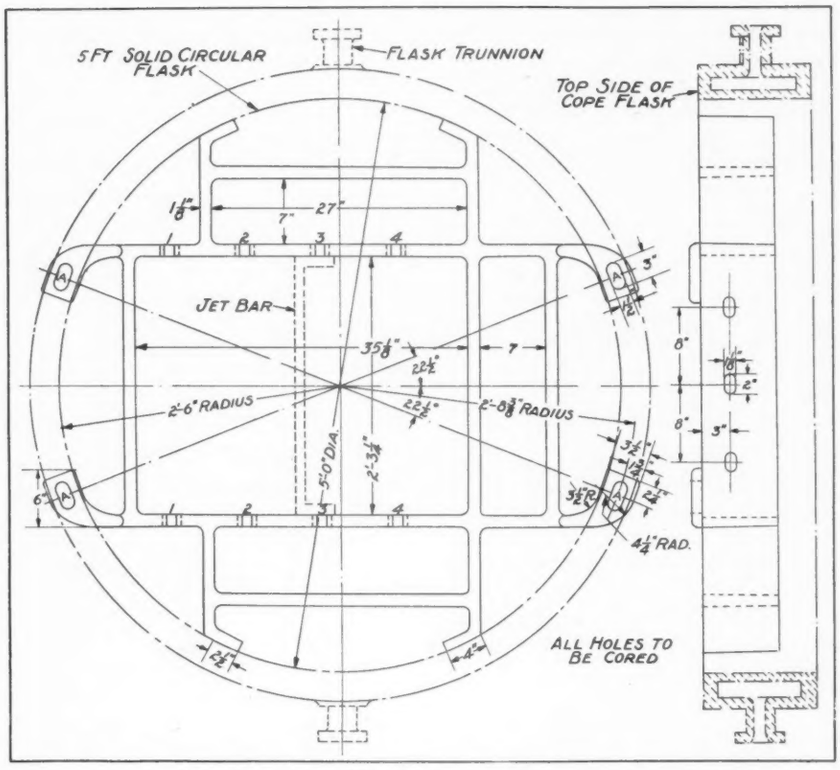


FIG. 1—CAST STEEL ARBOR FOR A 5-FOOT CIRCULAR FLASK

the demand for a metal tough enough for making certain fuse and other parts, and at the same time composed of metals which are comparatively plentiful. This metal contains no tin. It is an alloy of zinc, copper and aluminum, and contains traces of two other elements. Despite the fact that it contains 80 to 85 per cent zinc, its tensile strength exceeds 39,000 pounds. It is designed to be suitable for die and sand castings for which zinc base metals usually are employed and its physical qualities permit it to be used in the production of certain fuse and aeroplane castings. This metal melts at slightly above 800 degrees Fahr., or just above the melting point of zinc. The new alloy is said to be 18 to 25 per cent lighter by volume than any other standard zinc base alloy. Castings made from it have exactly the same color as aluminum castings, but it is possible to pour them through much smaller gates since the new alloy has a higher fluidity than aluminum alloys.

Wood Alcohol—A Poison

By M. E. Duggan

State and municipal officers all over the country have given warning repeatedly against the use of wood alcohol under conditions in which it can effect the health of workers. Wood alcohol has a disastrous effect upon the eyes. Continued or interrupted exposure to its fumes injures the power of vision. We are told that one or two tablespoons of wood alcohol taken internally promptly destroys the eyesight. It causes blindness and there is no known remedy.

Not many patternmakers know of the disasterous effects resulting from the careless handling of wood alcohol. The container in which wood alcohol is kept should be marked *poison* in plain letters and the container should be stored under lock and key. Wood alcohol, in some shops, is valued little more than water, judging from the careless way in which it is used.

The following are a few incidents that have come under my observation. In a large shop where I was employed, it was common practice for the workmen in the other departments to go to the pattern shop for their supply of wood alcohol. In their work they used both the clear schellac and black varnish. these required frequent *thinning* with wood alcohol. When the proper order was presented I gave out the alcohol without asking questions. Here are some of the purposes for which the wood alcohol was used. One workman rubbed wood alcohol on his gums to stop an aching tooth. Another used it to reduce a swollen cheek. And still another poured wood alcohol on his leg through his trousers believing it to be a good cure for rheumatism. I worked for 20 years at the patternmaking trade before I learned of the injurious effects of wood alcohol on the eyes through careless use.

Flask Arbor and Jet Bar for a Circular Flask

By George W. Childs and J. Rafferty

The flask arbor and jet bar shown in the accompanying illustrations were designed with the object of simplifying molding operations and reducing foundry costs. By using these the need of flask bars is eliminated, thus saving the flask fitter's time.

Fig. 1 shows an arbor designed for a 5-foot, solid, circular-cope flask. The flask is indicated by the broken lines. The arbor is fastened to the top of the flange of the cope flask by means of bolts at the points *A*. The arbor is a steel casting and its approximate weight is 720 pounds.

Fig. 2 is a jet bar for the flask shown in Fig. 1. It is also a steel casting and weighs about 68 pounds. It is fastened to the central portion of the arbor where the risers are placed for pouring the casting when the flask is in use. The jet bar is indicated in Fig. 1 by dotted lines and it can be fastened in place at the points marked 1, 2, 3, 4.

Metals formerly were regarded as opaque bodies, but the Coolidge tube generates rays so intense that they will penetrate 4 inches of hard steel. Photographs can thus be taken of the interior of the metal that will reveal flaws with a diameter as small as 0.02 inch located well in the interior.

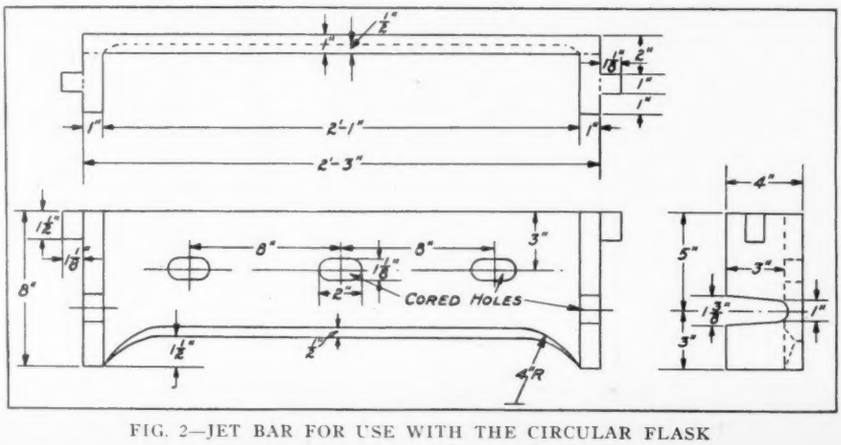


FIG. 2—JET BAR FOR USE WITH THE CIRCULAR FLASK

British Foundrymen Discuss Weighty Problems

After-the-War Conditions Considered by President Firth Who Urged the Removal of Limitation of Output and Specialization to Increase Production

NOTWITHSTANDING the great activity of the foundries in England, Ireland and Scotland, the annual meeting of the British Foundrymen's association, held at Sheffield recently, was unusually well attended. The proceedings included the reading of a number of interesting papers on current foundry topics, luncheon and dinner at the Grand Hotel, and an inspection of the steel foundries of Thomas Firth & Sons, Ltd. The membership report showed an enrollment of 1058, an increase over the total of last year. Among the papers presented were the following: The Fluidity of Molten Cast Iron, by Matthew Riddell; the Deformation of Steel Castings, by T. Brown; the National Information Bureau for Foundrymen, by R. Buchanan, and Notes on the Influence of Some Special Constituents of Cast Iron, by A. Campion.

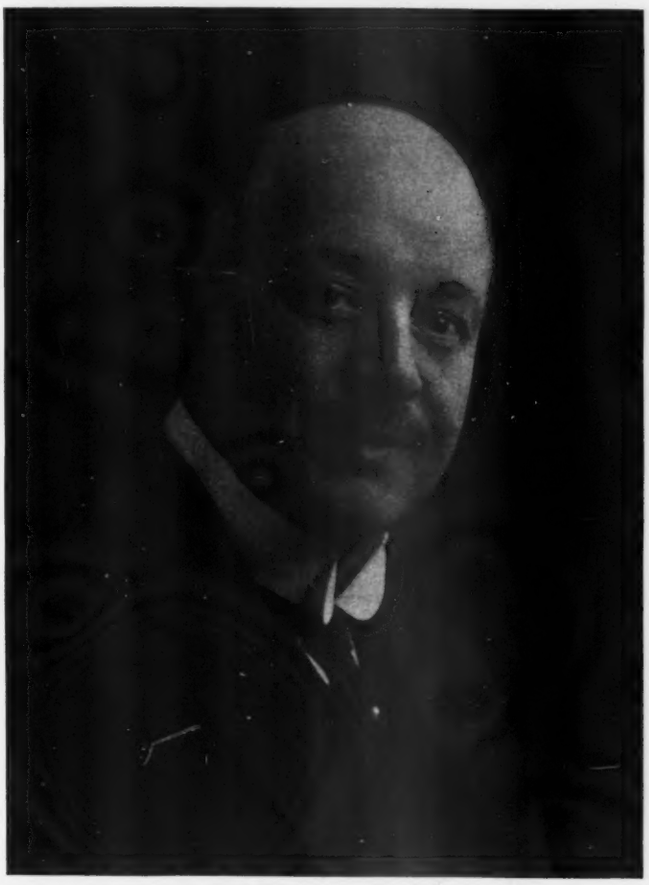
Officers for the ensuing year were elected as follows: President, Thomas H. Firth, Brightside Foundry Co., Ltd., Sheffield; senior vice president, John Little, and junior vice president, M. Riddell. E. H. Pilkington, who served as secretary of the society for many years, was compelled to tender his resignation owing to other pressing activities. He was succeeded by Capt. A. Hayes, London. The following were elected to membership on the council: Dr. W. H. Hatfield, J. Shaw, H. L. Reason, J. Oswald and H. Jewson. It was suggested that hereafter all foreigners be excluded from membership in the association, but it was subsequently decided to admit all but enemy aliens. In his presidential address, Thomas H. Firth directed attention to the effect of the war upon industrial conditions and business activities throughout Great Britain. His remarks are reproduced in part as follows: "One of the most important aims of our association is education and I wish to speak of this on very broad lines, in order to impress both employers and employes, that one of the first things we must do as a nation is to see to it that better relations are created.

"Men should have continuity of employment. This, I think, is one of the most important points we have to consider. I cannot see that it is fair for any employer to be able to go to any particular class of men who have been working well and doing their duty and give them a week's notice just because the firm happens to be short of work. To solve this problem we want government co-operation, not government control, and I feel sure that if all were to pull together, something could be worked out which would insure some sound scheme.

"I believe it could be easily arranged, for every man to be guaranteed a minimum wage, but not a maximum wage, which would be big enough for him to keep his wife and family respectably. The working hours also should be reduced, so that the employe will have time for study and recreation. In return for this, the workman must give his best without restriction, so that every man who wishes, can earn considerably over the district rate for any particular trade. It should, of course, be clearly understood that piecework prices must be arranged so that this can be done, and that prices in no way must be cut.

"Both employers and employes will have to be educated to see clearly that they are both interested in the same way, namely, that what is good for the employer is also equally good for the employe. If these theories could be carried out, restriction of output, which I look upon as one of the greatest dangers to the industrial stability of the country, would be impossible.

"We should then find that the high cost of living, and other expenditures would be reduced, and this is surely the only method of our meeting foreign competition, which will have to be seriously faced at the termination of this terrible war. Specialization is one of the things, we, as founders, will have to go in for. There are too many foundries known as jobbing shops; some of these always will be required, but generally speaking, we must specialize if we are to compete. We cannot do this alone, but must get the engineer, designer and constructor to work with us, so that, if a turbine casting or a motor of a certain type is wanted, some general design for the particular size can be agreed upon for all industries of the country, which would permit standard patterns, flasks, etc., to be made and quantities could be ordered at one time, and if necessary, stocked. By this means production would be increased, cost reduced and supervision lessened. Production in Great Britain will certainly have to increase to enable us to



THOMAS H. FIRTH,
President-elect of the British Foundrymen's association

continue the same standard of living that we are enjoying at present.

"It has often been said, that molding is an objectionable trade, and that some boys do not like it on that account; I think perhaps there is something in this. You never saw a dirty molder in Germany and in this we must copy them. All foundries and engineering works should be supplied with lavatories and cloak rooms, so that everyone could wash and change or take off overalls. This I know has been tried, with not very satisfactory results, in some works here, but if we begin with the apprentice when he first comes to the works, he will grow up to appreciate little comforts of this kind.

"We must educate the workers to place more trust in their employers and with this in view, my own firm has employed a supervisor to look after the welfare of the boys. Our object is not only to help them in their work, their education, and their sports, but to teach them self-reliance, to regard the welfare of others and to realize their duty to their king, their country, and the empire. Our country, we are told, never can be the same again as it was before the unprecedented conflict through which we, and our gallant allies are now fighting toward the great victory, which will secure for the nations a righteous and permanent peace. The unity of our people in the stern ordeal of battle must lead to a far larger measure of unity than before in the paths of trade and commerce.

"We must remember and apply the lessons this war teaches us, to be more and more a self-contained empire than we have ever been; to secure all that is possible in industrial and manufacturing production within the empire, and to make sure, after the full and vigorous development of our own vast imperial resources, that the nations with whom we are fighting hand in hand, shall at the very least, have full consideration over those whose aims have been lust of conquest and world domination.

"How this can most effectually be secured is noble work for the best brains of our own and allied peoples.

"The great duty before us as a nation and an empire, is to do the work that is nearest our hand, and to do it thoroughly. There must be no foolish adherence to old, worn-out theories, but ready, full, and enlightened recognition of the changed conditions brought about by this tremendous upheaval among the nations, and in our country, employer and employed must more and more realize the imperative need for the closest possible harmony in working, the lightening of labor wherever possible, and the thorough resolve to secure the fullest production in the essentials of the world's industries, under the best obtainable, practical conditions, for those who are engaged in the work.

"The valor and endurance of our men at the front has been vigorously backed by the unwearying and tireless energy of the men in the foundry and at the furnace, and by men and women alike in the workshops of the country; and there is increasing confidence everywhere that the lessons of self-sacrifice, self-denial, and recognition of the rights and duties of all, whether employers or employed, will lead to still brighter days

MOLDING FLOOR OF THE STEEL FOUNDRY OF THOS. FIRTH & SONS, LTD., SHEFFIELD, ENG., VISITED BY THE MEMBERS OF THE BRITISH FOUNDRYMEN'S ASSOCIATION

in the great realm of industrial Britain.

"Let each of us do his part to bring about this much-to-be-desired result, and there will assuredy come those brighter conditions wrought in the glowing furnace of this world war.

"Gentlemen, to the splendid foregatherings of our own people in the home land and the mighty young nations beyond the seas, who have so gloriously rallied round their dear mother country, has come the noble

CLEANING DEPARTMENT OF THE FOUNDRY OF THOS. FIRTH & SONS, LTD., SHEFFIELD, ENG., INSPECTED BY BRITISH FOUNDRYMEN

race whom we are proud to welcome as of ourselves. Every day adds to the strength of their forces by sea and land, and they have already given, and will continue to give, brilliant proof of their power and their prowess in the mighty struggle of right and against wrong, of freedom and humanity over tyranny and frightfulness.

"Let us all look forward with firm faith and resolute determination for the coming of the sunshine of peace, with victory for the great cause which has brought the Anglo-Saxon peoples of England and America, into perfect line with their gallant allies of France, Italy, Belgium and other lands, along the far-flung battle line."

The establishment of a national information bureau for foundrymen was recommended by R. Buchanan, of Birmingham. Such a bureau, he believed, for the first few years of its existence should engage in collecting, cataloging and disseminating information at present available. This would be obtained from books, pamphlets, lectures, articles in technical journals, etc., and advice on practical subjects also would be given by those best experienced in the line of work concerning which information would be sought. For this purpose a list of the names of men engaged in foundry work in various branches would be maintained at headquarters and for the purpose of answering inquiries one of these men, best qualified in that particular branch, would be requested to give his personal help. For this purpose the country would be divided into districts and a small committee might be appointed for each section.

If experiencing difficulty, foundrymen would write to the bureau and if it appeared necessary, the bureau would request the local committee, either in whole or in part, to deal wth the problem. He also suggested that another feature of the work would include the investigation of various tests used by foundrymen. This would involve shop tests as well as analyses, etc. Mr. Buchanan believed that a bureau of this kind might most effectively be operated under the auspices of the British Foundrymen's association. He was of the opinion that a bureau wholly supported by the government would not be established, while under a part voluntary and part governmental scheme, contributing firms would get assistance free of cost. A small fee would be charged non-contributing firms and all expenses would be defrayed covering personal visits to the shops to give them advice. After the bureau would be firmly established, he suggested that it undertake research work.

In discussing Mr. Buchanan's recommendations, H. L. Reason, a member of the provisional committee appointed by the department of scientific and indus-

trial research to organize research upon co-operative lines for the nonferrous metals industries, said he was in sympathy with the suggestion. He pointed out, however, that if the bureau could be started on the lines recommended, it could do research work of the highest order by collecting all available information covering the principal difficulties experienced by foundrymen. He explained briefly the organization of the British Nonferrous Metals Research association which would consist principally of manufacturers who will pay subscriptions based upon their working capital and wages distributed annually. The government has consented to contribute annually an amount equal to that subscribed by the trade, but this grant is only for a limited period, approximately five years. The government recently made an appropriation of $5,000,000 for research work, a large amount of which already has been applied to aid other industries. He suggested that the foundrymen take some definite action to obtain a part of this appropriation as otherwise it probably would be fully allotted before they had an opportunity to act.

Scientific Study Needed

M. Riddell stated that the study of cast iron largely has been neglected by scientists and he believed that there was great need for an extension of scientific interest in this subject. R. Carrick recommended that the establishment of a research bureau be referred to all the branches of the British Foundrymen's association and it was decided to refer the subject to the council with the object of appointing a subcommittee whose duty it would be to present to all the members of the British Foundrymen's association a brief regarding the proposed establishment of its central information bureau and the purpose of its activities.

"Notes on the Influence of Some Special Constituents of Cast Iron," was the subject of a very interesting paper, by A. Campion, professor of metallurgy, Royal Technical college, Glasgow. He reviewed all of the existing literature dealing with the addition of nickel, chromium, molybdenum, tungsten, boron and vanadium to cast iron and pointed out briefly the results that had been attained with these alloys by investigators.

The Fluidity of Molten Cast Iron

By Matthew Riddell

THE many varied and widely divergent views which are held by experienced foundrymen concerning the correct construction and the proper manipulation of the cupola are too well known to need recounting. The mere fact that after so many years of experience and discussion, there should be still such diversity of opinion on this topic is noteworthy. It would seem to indicate that either the cupola, or its process, is not the simple matter it appears to be, and that some more scientific explanation than common sense is required for the solution of the problem.

The fluidity of cast iron depends on the amount of superheat or number of degrees of temperature over and above its freezing temperature that has been imparted to it in the cupola. The greater the superheat the greater will be the fluidity or degrees of life possessed by the metal and, other things being equal, the longer will it remain fluid to fill up the intricacies of the mold.

Dull Iron

When the metal runs dull from the cupola and is sluggish, its degrees of temperature or life are not far removed from the solidifying temperature. It is deficient in superheat. The reasons which one may hear ascribed in the foundry for the poor working of the cupola are many and various. Some blame the air supply as too great or too strong; others would have the quantity or pressure reduced; but the majority, recognizing that the coke plays a most important part in the production of heat, and knowing that the manager is prompted by considerations of economy in the use of this material, are inclined to conclude that economy has been carried too far. To these the sure remedy is more coke. It seems but natural to suppose that an increase of coke ought to result in a larger amount of heat being developed in the cupola. No doubt it does so result, but repeated experience shows that after a certain limit of coke in the charge has been reached further additions appear to make the metal more dull instead of more fluid. This and some other peculiarities of the cupola which seem to defy common sense explanations have for a long time puzzled the writer, and the solution herein advanced occurred to him while investigating the problem in connection with semisteel difficulties.

Among the peculiarities which the present argument appears to solve satisfactorily may be mentioned the following: Better results are obtained in securing hot metal when the bed coke is not well lighted above the tuyeres, before the blast is put on and the first iron takes longer to come down, than are secured when the opposite conditions prevail. Many foundrymen have noted this peculiarity, but explanations have not been satisfying. Also, it has been noted that foundry irons with high silicon are generally fluid, while those with high sulphur are inclined to be sluggish when melted under similar cupola conditions. It appears generally to be taken for granted that the actual temperature at the spout of these different classes of irons is the same, or approximately so, in all cases, and that the fluidity or sluggishness of the metal is due to some inherent quality of the respective elements—silicon and sulphur.

Not Satisfactory for Superheat

An examination of the cupola and of its load will show that as an instrument for imparting superheat to a molten metal it is as unsatisfactory an arrangement as could have been devised. It is divided into three zones, as follows: (1) The bed into which the metal flows as soon as it is melted; (2) the melting zone where the maximum heat is developed and the solid metal converted to the fluid state; and (3) the stack wherein the descending charge is being heated by the ascending gases.

From the foregoing it will be noted that the point at which the temperature is high enough to melt the solid iron is well removed from and over the basin or well into which it flows when melted. After the door of the cupola has been made up there is no combustion going on in the bed coke below the tuyeres and, therefore, no heat is being generated in that quarter. So soon as the metal reaches its melting temperature and becomes fluid in the melting zone it passes rapidly away from this high-temperature zone into the basin at the bottom of the bed. In some cases, where a separate receiver is used, it passes out of the cupola altogether, and consequently cannot come under the influence of subsequent heat. What little superheat the metal may have acquired at the region of maximum temperature

From a paper presented at the British Foundrymen's association.

Payment will be made for all contributions on foundry and pattern shop practice suitable for publication

Note—This sheet may be cut into two sections, 5 x 7 inches, and may be readily bound in note-book form.

FORMULAS FOR THE BRASS FOUNDRYMAN

Fluxes for Nonferrous Alloys

Flux for Yellow Brass

	Parts
Salt cake	5
Silica	15
Coal dust	5
Bone ash	20

Salt cake is sodium sulphate and either the acid sodium sulphate or the sodium sulphate may be used. Silica, of course, is sand and bone ash, calcium phosphate. This flux is used in the proportion of 1 or 2 per cent on the melted metal.

Flux for Grindings

	Parts
Plaster of paris	1
Soda ash	1
Salt	1
Fine charcoal	1

Mix the various ingredients thoroughly, and use from two to 10 pounds to 100 pounds of metal. Mix the flux thoroughly with the grindings, and melt at a high temperature.

Flux for Red Brass

	Parts
Powdered glass	8
Calcined borax	1
Fine charcoal	2

Mix the ingredients thoroughly, and use on red brass in the proportion of approximately 2 per cent.

Bell Metal Flux

	Parts
Soda ash	1
White sand	1
Borax	0.25
Yellow prussiate of soda	1

Mix thoroughly and use 1 per cent on bell metals after they are fluid. Add the flux, let it heat for a few minutes, then stir into the metal. This flux improves the tone of bell metals.

FORMULAS FOR THE BRASS FOUNDRYMAN

The Hardness of Bearing Metals

Hardness tests carried out by F. Giolitti and M. Marantonio, of Italy, gave the following results:

Copper, per cent	Tin, per cent	Lead, percent	Hardness, Brinell
95.50	4.50	.....	49
91.20	8.80	.....	63
83.70	16.30	.....	77
74.10	25.90	.....	230
91.10	3.90	5.00	46
87.00	8.00	5.00	61
81.20	13.70	5.10	93
87.00	2.40	10.60	39
81.60	8.00	10.40	48
75.70	13.90	10.40	86
81.80	4.10	14.10	39
75.50	9.20	15.30	57
75.00	5.00	20.00	44
68.00	12.00	20.00	70
80.00	.....	20.00	23
60.00	.....	40.00	13

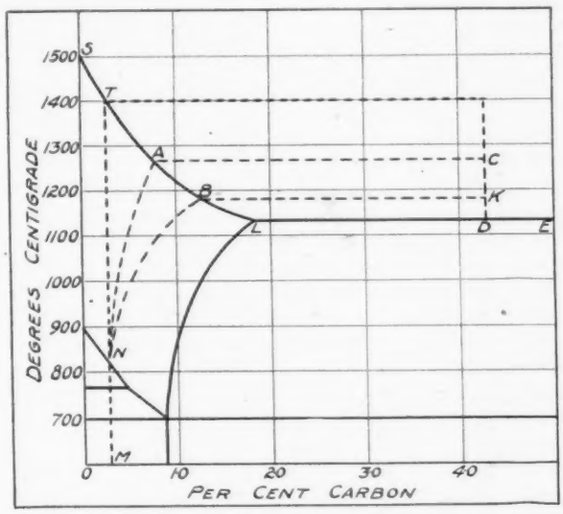
The foregoing results were obtained on cast alloys by the Brinell hardness testing method. A steel ball, 10 millimeters in diameter was used, and the pressure applied was 500 kilograms, or 1100 pounds. The results indicate how hardness is affected by the content of lead and hardness increases in proportion to the percentage of tin added.

is largely discounted in its journey to the bottom of the cupola. Besides having to pass the tuyeres, which are discharging large quantities of cold air into the furnace, it will have to part with some of its heat to the coke which makes up the bed. If there was nothing more involved in the melting of metal in the cupola than the question of heat it would be extremely difficult to account for one kind of iron coming out more fluid, and therefore hotter, than an iron of a different class. Under similar conditions of melting all metals should have imparted to them the same degrees of heat.

It is a common belief that all substances which pass from the solid to the liquid state and *vice versa* make these reverse changes at the same temperatures. For instance, ice becomes water when the temperature begins to exceed 0 degrees Cent. and water changes back into ice as the temperature begins to be less than 0 degrees Cent. Every substance has its own melting and freezing points which are supposed to be identical for each substance. This assertion is true of all simple bodies or of alloys which retain their components in solid solution. It is because pig or cast iron is an exception to the rule that the cupola is practicable at all as a melting instrument. If any of the materials which adhere to the rule were melted in the cupola they would probably resolidify in the bed, or at the best would come out of the cupola so dull as to be useless for casting purposes, owing to the lack of superheat or life.

To investigate the behavior of cast iron in the cupola and to ascertain, if possible, why it should be an exception to the general rule, it will be necessary to refer to the accompanying equilibrium diagram and the information it gives concerning the iron-carbon series of alloys.

The main fact to be noted is that both the melting and freezing temperatures depend on the amount of carbon in the alloy, that is, the amount of carbon in solution in the iron at the time. The lower the amount of carbon which is in solution the higher is the temperature at which the changes of state take place. The lowest freezing or melting temperature is at about 1130 degrees Cent., but it is only such an alloy as has about 4.3 per cent carbon to 95.7 per cent iron that will freeze or melt at that temperature. An increase in the amount of either of the elements in solution results in an increase of the temperature at which the changes take place, 4.3 per cent is the saturation point of carbon in iron when these two elements are reckoned alone. With ordinary pig irons this figure obviously requires adjustment on account of the presence, in greater or lesser quantities, of other elements. For the purpose of the present argument it may be taken for granted that foundry irons contain very near the saturation amount of total carbon. If all the carbon of a 4.3 per cent total carbon or saturated cast iron were in solution or combined with the iron, the metal should melt or freeze at about the temperature of 1130 degrees Cent. Fortunately for the reputation of the cupola the carbon in pig iron is found separated out as graphite as well as being in solution or combined in the iron.



EQUILIBRIUM DIAGRAM BASED ON THE PER CENT OF CARBON IN CAST IRON

As the melting temperature is determined by the amount of carbon in solution only in the iron at the time it reaches the melting zone, the free graphite is left out of account. It follows, therefore, that an iron which is very low in combined carbon, although high in total carbon, cannot be melted until a very high temperature is reached. The mass or body of metal will remain in the solid condition until the high temperature is attained, and consequently the liquid metal will be extremely hot. In the course of melting the free graphite is rapidly dissolved and enters into solution with the iron, with the result that the molten mass has a high percentage of combined carbon and therefore a low freezing point. Under such conditions an iron which will not melt until it has been heated to, say, 1400 degrees Cent., does not freeze again until the temperature has fallen to about 1130 degrees. Such a metal may be said to have 270 degrees of life and will appear fluid.

If, on the other hand, the combined carbon in the pig iron is already high, the temperature at which melting begins will be low, and even after the free graphite is dissolved will possess only a few degrees of life or superheat.

Another point which the writer would like to emphasize is that it is the amount of carbon in solution at the time the metal enters the melting zone, and not necessarily that of the original iron charged into the cupola that determines the temperature which will be attained in the process of melting. It has to be borne in mind that after iron has reached a certain temperature much below its melting point and has been converted into gamma iron it dissolves carbon very readily. This implies that if in the course of heating, graphite is being reduced while the percentage of the combined carbon is increasing in the iron, the melting point will be lower than indicated by the original analysis. It is obvious that in order to obtain the hottest melted metal it is essential to get the unmelted iron into the melting zone as quickly as possible. The absorption of the graphite is not instantaneous, but the rate at which it takes place increases as the temperature rises. When, therefore, the descent down the stack is slow and the metal is held above the melting zone through excessive coke in the charges, the iron is afforded an opportunity to dissolve the graphite, with the result that the material enters the zone with a lower melting temperature than it otherwise would have had. One can see from this an explanation of why excess coke results in duller instead of more fluid iron. The same explanation applies to the bed coke. If this is too high, or if the bed is so burned up that the metal is brought to a red heat, in many instances little short of actual melting, before the blast is turned on, the amount of graphite that has entered into solution will be considerable, and the pig will melt at a comparatively low temperature. So long as the first charge is resting on coke which is not yet alight when the blast is turned on, its combined carbon is unchanged, and the quick combustion of the coke by the blast raises the maximum temperature in the cupola before the absorption of graphite has been able to proceed along very far.

The theory likewise explains the reason of the differences in the fluidity of siliceous irons, as it is only necessary to take into account the accepted actions of silicon and sulphur with regard to the solubility of carbon in iron. Silicon by reducing the solubility makes it more difficult for the graphite to become absorbed while the temperature is being raised, while the influence excited by sulphur is all in favor of combined carbon.

In a previous paper on the subject of semi-steel, the writer, arguing from the equilibrium diagram, advocated the use of high carbon steel, such as files, etc., because of the greater ease and lower temperatures at which such material could be melted. Experience has proved that the results to be obtained from mild or low carbon steel are superior to those which the use of files will afford. Does not the theory here offered suggest an explanation in that the question of superheat and its source was overlooked? The high carbon steel with all the carbon in the combined form would have a lower melting temperature than the pig iron itself, and its influence would be to impart a dullness to the molten mass, and so render its homogeneity more uncertain. In the case of phosphoric irons, in which the fluidity is such a marked feature, it is necessary to look to the diluting effect of the phosphide eutectic. The phosphide eutectic becomes fluid at about 950 degrees Cent., and so long as it remains entrapped in the otherwise solid metal it is acquiring superheat and increasing its fluidity accordingly. As this phosphide eutectic may constitute 15 per cent, or even more of the mass under treatment, the diluting effect of such a considerable volume of highly fluid material is manifest.

Conclusions Reached

The foregoing statements may be summarized briefly as follows:

The fluidity of cast iron depends on the degrees of heat which it has attained in excess of the freezing temperature.

The cupola is not suited to impart directly superheat or fluidity to any material which is being melted therein.

While the freezing temperature of foundry irons for all practice purposes, may be taken as constant, at about 1130 degrees Cent., the melting temperature varies, and is regulated by the amount of carbon in combination or solution when the material enters the melting zone.

In view of the gradual absorption of carbon into the iron as the temperature rises the practical conclusion suggests itself that in order to obtain the molten metal in the most fluid condition the solid material in the cupola should be introduced into the melting zone as quickly as possible.

Excess of coke in the charges, too much coke in the bed or too fierce burning of the bed before blast is turned on must result in dulling the iron.

Equilibrium Diagram

On the accompanying diagram an attempt is made to illustrate graphically the principal features of the foregoing remarks. *SLDE* is the solidus curve of the equilibrium diagram. Any alloy of iron and carbon whose ordinates of concentration and temperature intersect below the curve can normally exist in a completely solid state. Before the alloy can become in any way liquid the ordinates must intersect above the solidus curve. Above *SDE* the alloy is completely liquid and begins to solidify, when the ordinates of concentration and temperature intersect on the curve.

The dotted curves represent the melting and freezing processes of an iron with 0.3 per cent combined carbon, 4 per cent graphitic carbon, the balance of 95.7 per cent being assumed to consist of iron only.

If the temperature of the solid metal is raised without change taking place in the carbon arrangement it will attain to 1400 degrees Cent. before the metal will begin to melt, as indicated by the dotted line *MNT*. The curves *MNA* and *MNB* show the difference brought about in the temperature at which the metal begins to melt, through free carbon being absorbed in solid solution in the iron while the mass is accumulating heat. After the temperatures *TAB* have been acquired, and as the metal melts the remaining free carbon is rapidly dissolved as indicated by *TF*, *AC* and *BK*. The liquid solutions each containing 4.3 carbon in combination have temperatures *F*, *C*, and *K*, respectively, but all begin to freeze at the same temperature *D* (1130 degrees Cent.) The superheat or fluidity of the first is *FD*, which is greater than that of the second, *CD*, and still greater than that of the third, *KD*.

Dr. W. H. Hatfield complimented the author on the development of the equilibrium diagram adding that he entirely confirmed what Mr. Riddell had said concerning its importance. From the metallurgical standpoint it was impossible to understand the properties of cast iron until the diagram had been properly studied. Prior to writing his book on *Cast Iron* Dr. Hatfield spent three years in following through the evolution of the diagram. However, he was unable entirely to follow Mr. Riddell in his deductions. The diagram was constructed on cooling curves of alloys containing from nothing to 5 per cent of carbon. Mr. Riddell had been deducing his conclusions from the properties of low carbon alloys, namely, steel, containing 0.2 to 0.9 per cent of carbon. The term equilibrium must first be understood, added Dr. Hatfield. It means that if an alloy is maintained for a sufficiently long period at a certain temperature certain phases or conditions will be realized. The *D* point on the diagrams is the eutectic and if 4.3 per cent of carbon is in a carbon alloy, freezing would take place at about 1130 degrees; but in ordinary cast iron containing from 1 to 3 per cent of silicon, the freezing point of the iron is modified. The first result of added silicon is to reduce the solubility of carbon. If an iron containing 3 per cent of silicon with, say 3.2 per cent of carbon was gradually raised in temperature it would be found that the carbon absorbed would be in conformity with the diagram. Dr. Hatfield could not agree with the theory that with the cupola it is possible to heat a piece of cast iron to a temperature so high as had been indicated without fusion taking place. He suggested that Mr. Riddell reconsider his theory in the light of the suggestions offered and he thought he would find that equilibrium would be attained much more readily than was stated in the paper. In actual foundry operations ordinary foundry iron containing 1.5 per cent of phosphorus could be melted in a much shorter time than Mr. Riddell had said, and the smallest articles could be cast therefrom, the degree of superheat being sufficient.

Mr. Riddell said that his equilibrium diagram was built-up in the simplest possible way and he did not believe that the changes took place so rapidly as Dr. Hatfield indicated. He had personally conducted some experiments in melting crucible iron at different rates in order to ascertain the temperature to which he could raise it before it became fluid. But he agreed that the presence of silicon reduced the rate of progress and promoted fluidity in cast iron.

Hot Iron Soft

R. Carrick said he would like to draw attention to certain statements made by Dr. Hatfield. Although he was not a metallurgist he had made thousands of practical tests of cast iron and he had never yet found that the higher the temperature of cast iron the more likely hard iron was to be obtained. He thought Dr. Hatfield might offer, at some future time, a further explanation. Mr. Carrick had tested for hardness with the Brinell and other machines and his own experience certainly did not confirm that statement. He thought most foundrymen agreed that the hotter they cast the iron the softer it would be. Leaving aside the question of

chemical content he thought mechanical tests would confirm that theory.

Dr. Hatfield replying to further remarks said that his statement with regard to the effect of temperature was based upon actual experiment and observation, and many of those experiments could be easily carried out. He had found that iron cast hot was distinctly harder than iron cast cold. He could give actual experimental data in support of that statement. His experiments consisted of a gradual increase in the silicon content and he really did the work primarily to see how the results compared with those published by Professor Turner in 1881. He increased the silicon content by stages of 0.25, 0.50 and 0.75 per cent up to 3 per cent of silicon ,and then he determined the result by fracturing the casting and testing both the combined carbon and the mechanical properties. One thing he discovered was that the gradual addition to the silicon content did not result in a gradual precipitation of the graphitic carbon. In his remaining series of experiments he found that the combined carbon remained at a high maximum well over 3 per cent until a certain silicon content was reached, and then he found a rapid drop. In that series the casting was done at a fairly cold temperature. In the next series with the silicon contents identical he cast much hotter and he found that the combined carbon persisted until the higher silicon content was reached and that was confirmed over and over again in works practice. If they had a very heavy casting with a sufficiently high silicon the effect of casting temperature would be different because they would always have a maximum softness.

F. J. Cook said that Dr. Hatfield's concluding remarks contained the crux of the whole subject. It was not only a question of hot or cold casting temperature, but also a question of the rate of cooling. When dealing with hard iron which cooled quickly, as for superheated steam engine cylinders, the metal was susceptible to hardness and, therefore, susceptible to the influence of the rate of cooling. If they were not careful they got very hard iron before they were aware of it. If the range of cooling was increased the possibility of softness was increased. He did not wish to throw doubt upon what Dr. Hatfield had said, but personally he had cast thousands of cylinders and there was no doubt that in casting cylinders with metal of the kind he had described at a high temperature they would be more easily machinable than if cast with metal of the same analysis cast cold. That was due simply to the different rate of cooling rather than temperature effect.

The Deformation of Steel Castings

By T Brown

MY paper deals chiefly with steel castings. I am fully aware that contraction plays its part in cast iron, but not to the same extent as in steel, owing to the high temperature of the latter. The contraction of cast steel is considered to be equal to about 1 in 60, but in cast iron a good deal less is allowed. In some shops men are kept for the sole purpose of putting deformed castings into shape as required for delivery. Should a casting be badly out of shape, before it is put into the annealing furnace, they make a careful study of how it should be packed, so that when hot enough it will bend by its own weight, or, if the section is too strong, they will apply extra weight to bring it back to the shape required when cooled down.

Causes of Deformities

I have seen mistakes made with regard to packing in the furnace. I have seen every allowance being made for the particular casting to return to its shape, or it may have been right before putting it in the furnace, but no thought has been given to the casting expanding lengthwise while getting hot, with the consequence that it has been more out of shape than previously. This is a matter that needs careful consideration before the furnace is heated.

The object of my paper is to try and show what I think would not only save a lot of anxiety to the foreman, but would also save a great deal of the work done by the men referred to in straightening these castings.

I will divide the deformities that occur into two classes:

First—By contraction from the solidification of fluid steel down to complete cooling.

Second—By expansion from the cold stage to the higher temperatures of annealing.

Deformed Stern Frames

Some years ago I worked in a shop where many stern frames for merchant boats were made; they were of various designs, but the only one I want to refer to is what is known as a plain frame. We never made one at that time which was not out of shape. I remember the patternmakers coming into the foundry to set the pattern after the molders had prepared the bed for it; lines of string were used as well as straight edges and parallel blocks, yet when the castings came out and were delivered to the machine shop they were not lineable as the pattern was when set in the floor. Many things were considered as the probable cause, but the same thing constantly occurred. Eventually a man was appointed to make a study of setting the castings in the annealing furnace, with a view to bringing them back to shape whilst getting hot. I may say that at that time I was equally at a loss as to the cause, but it only requires a little study to discover it. The worst trouble was that the lugs or gudgeons for carrying the rudder, were never in line, although they were correctly set when putting the pattern in the floor.

This, in my opinion, is a clear case for the patternmaker to set the pattern to the expected deformities when molding, so that when the casting is knocked out it will not require the labor of a man to set it to shape. I have no doubt the shop referred to will by this time have solved the problem and taken steps to avoid such trouble, but I have only mentioned this as an illustration of what does take place if precautions are not taken.

Anvil Casting Exploded

Another kind of deformity—if I may use the term—which sometimes occurs in steel castings, and in what I consider the worst form, is breaking due to contraction, and in these instances I must exonerate the patternmaker. I will here verbally illustrate an instance that I personally witnessed. A base for an anvil block was cast; its dimensions from memory would be approximately 10 feet square and 16 inches thick, with a dovetail piece running all round its top side for packing the anvil block. Now this was a breakdown job, and was most urgently required to replace a cast iron one. I well remember it being cast, and to help it to cool quickly the flasks were removed from the sides to allow the atmosphere to reach it, and, as soon as it was thought safe to lift, it was sent to the clearing shop, and, as soon as considered cool enough to commence work, it was stripped on the top and the sides, the

From a paper presented at the annual meeting of the British Foundrymen's association.

sand remaining on the bottom owing to the dovetail piece running all round it. In the course of a day or two it was turned over, and the sand taken from the bottom as cast. It was now cool enough (though warm) for some cleaners to sit on the top with hand hammers and chisels to level the surface where the anvil would rest, and while these men were so engaged it broke, and with a report equal to a heavy gun; it also brought down clouds of dust from the roof, which made it impossible to see either casting or men for some few minutes, but when all was again clear it was found that no one was hurt, a lot badly frightened, and the casting itself broke in two pieces almost straight across and 15 inches apart.

Now at that time I had no idea of what could have been the cause, but after having castings break under my own supervision, I thought it was time to look for the cause and the remedy, and the only conclusion I reached was that the castings were exposed to the atmosphere too soon.

Therefore, let us consider what happened in the case of the anvil base referred to. The outside of this casting being stripped, it was at once attacked by the cold air, and in consequence would contract; its outside would be in compression toward the center; this would continue until the outside was perfectly cold and compression had ceased; the center being covered with sand was causing the heat to be retained at this part, and consequently as it cooled it would have to contract, which would now bring the outside into tension, such a strain being imposed between the two that one must give way; the result was that the outside or cooled part being the largest in area, the center had to give with the result as stated, and the strain was so great that when it did break it caused the report referred to, and the sudden displacement of air brought all the dust down from the roof.

How to Prevent Cracking

In my opinion the best way to prevent breakage of this description is to leave the castings in the floor or flasks, as the case may be, until quite cold, and to prevent the atmosphere from reaching any part of them. I know in some cases castings are removed while hot and put into furnaces to cool down. Even in these cases great risks are taken owing to the casting being attacked by air in the process of removal. I am convinced that the safest way is to leave them in the sand, which will retain the heat all over and allow all parts to cool simultaneously. I do not remember one case of a casting being broken before removal from the sand. I am fully aware that, to do as I suggest, a lot of floor space, or a lot of flasks, will be required, but it is advisable rather than to take the risk of losing valuable castings. One of the greatest assets a steel founder can have is plenty of spare room or flasks for any eventuality. This will always allow him to proceed with a new job while another is cooling in the floor or in the flasks.

Heating Steel Castings

Now I come to the second stage of my paper, namely, castings deformed in passing from the cold state to the higher temperatures. It is always essential that steel castings should be annealed or otherwise heat-treated. It is in this process we get the deformities I wish to refer to. I have seen castings considered perfect to shape before being put in the annealing furnace, but after being allowed to cool and removed therefrom, they have been various shapes. There are several reasons for this, but I will refer only to one or two causes. First let us look at a furnace where you have the heat coming in on one side or end only. The consequence is that the part of the casting nearest to the fire or gas is the part to become hot first, and will expand before the other parts reach the same temperature, and this is when it loses its shape. In some castings it may not matter much, but in others it becomes serious. Take for instance a large spur wheel with only a part of its rim exposed to the flame, and you can imagine that that part of the rim will expand and be out of shape, and will keep out of shape till the whole wheel is heated to one temperature, if such a thing is possible in the furnace referred to. When this state is reached the part that first commenced to expand is still out of shape, and as it cools down gradually and equally it is impossible for that part now out of shape to return to its original form, and the consequence is a deformed casting.

I have not yet seen the ideal annealing furnace. All the furnaces, in my experience, have been constructed so that the heat came in at the side or end only; but my idea of a furnace is one wherein the heat is distributed on all parts inside the furnace at one temperature, thereby preventing one part of any casting getting hotter than the other. Then expansion would take place equally, and with care you ought to have castings undeformed when taken from the furnace.

I will now proceed to discuss the breakage of castings. I refer to breaking after removal from the annealing furnace, which I do believe with proper care and less speed could be avoided. It is only another case of allowing the atmosphere to attack the casting before being properly cooled in the furnace.

I will give one or two cases of which I have personal knowledge. The first I refer to was a large fly wheel about 13 feet in diameter, with a light boss and six light arms, as compared with a very heavy rim. Great care was taken with these wheels after being cast, and owing to shortage of floor space for molding it was necessary to put them into a furnace while hot, to cool. When one was considered sufficiently cool, it was taken out, but the next morning it was found to have broken through the rim, also through three arms. Now let us look for the cause. I may say at first when it was taken out it was not quite cool, although considered safe, but proved not to be. What took place was, the rim having very little sand attached, the cleaners started to knock it off the boss and the arms, thus allowing the air to attack them, and being of light section were first to cool by contracting toward the center, thereby putting the arms in tension from the rim; the outside being warm, yielded to that tension, and this continued until the boss and the arms were cool, and contraction completed; but with the rim such was not the case, and being of much heavier section did not cool so quickly, and consequently the contraction proceeded after the arms were finished. The arms having already contracted, would not yield, and the result was that the rim had to give way and break.

Breakage of a Flywheel

I will give another case of a flywheel which occurred recently. This was a plate wheel about 12 feet in diameter and an 8 inch thick plate, without a heavy rim, as the latter was cast separately. Everything went well with the wheel from the cast to being partly finished, when it was put in the furnace for annealing; but owing to the urgency of the job and the furnace being required for other work it was regarded as safe to take out, but, unfortunately, the result was disastrous. What happened in this case, owing to the plate being thin as compared with the boss and feeding head combined, the air attacked the plate and caused contraction and compression toward the center till quite cool on its outer surface and contraction had ceased; but, owing to the center being of much heavier dimensions, it did not cool as rapidly as the plate, which then caused the outside of the plate to be in tension, with the consequence that the strains then set up caused the wheel to crack across, but it did not fly apart, and the only thing visible on the outside was a hair line, and the center had

opened ⅛ inch, which proves that the outside had ceased contraction before the center part had contracted to its minimum dimensions.

In discussing Mr. Brown's paper, John Watson said that he had found that silica core sand mixed with oil was a decided improvement over other mixtures and it enabled them to do away with irons altogether in certain cases. It was possible to make a triangular core with silica sand and reduce the thickness of the corners to within ½ inch of where the steel touched the core, so that when the contraction came on the core it would crush and stop and deformation of the casting. This class of core offered no resistance whatever to the contraction on the wheel. Another point where the molder sometimes goes wrong arose from the difference of opinion on the question as to whether the mold should be cast hot or cold, and his own impression was that when they cast in very hot molds they got the casting out of shape and out of size. Mr. Brown related how breakages had happened through strains when cooling. Mr. Watson disagreed with Mr. Brown. The author's idea was that the casting should be left in the sand until it was quite cool, yet he found that a casting so treated was in such a condition that when the cleaner hit it with a hammer it broke. His own practice was to lift out the casting as hot as possible, having everything in readiness to get it into the annealing furnace as quickly as possible. But it was first necessary to rough out all the cores. When a casting is put into the furnace some parts are quite clean of sand while others are not. It is much the better plan after the first annealing to get the cleaners on the casting as quickly as possible, cleaning off the sand, and then anneal it again in a clean condition. That was the best remedy for casting stresses.

Influence of Design

F. J. Cook said he had had no experience in making steel castings but with large flywheels of the disc type, made in cast iron, the strains were very much reduced if the plate was designed conical instead of flat. With many of these castings ranging in weight up to 25 tons this method had proved satisfactory.

W. Mayer said he had seen all sorts of malformed castings. He had adopted, with good results, the odd-arm system of making wheels for rotor turbines and other wheels of all kinds in both steel and iron, when great strength was required. By that system the direct line of contraction is broken and reduced in length, and it likewise had a tendency to reduce the tension strain that was left in the casting after it had contracted to the limit in cooling. With regard to the cooling of castings, his own practice was to leave a casting cool if possible, and they always made provision for contracting by means of the cores.

For example, the soft loam brick system had been found very effective and was used largely as an easy means in getting over contraction risks and troubles. Then again there is the wooden contraction bar which is put into large cores of box form. This is burned as the core becomes hot and the casting starts to contract to the final stage.

Suggested Precautions

A. R. Bartlett said it was interesting to note from Mr. Brown's remarks that the practice in the steel foundry was similar generally to that appertaining to the production of gray iron castings, more particularly to those of a large type. The author's co-operation with the pattern shop to meet and counteract the deformities mentioned, was undoubtedly the correct way to avoid this trouble, rather than the way some firms had of overcoming it by packing in the annealing ovens. Mr. Bartlett did not believe it would be a sound proposition to make cores entirely of loam because they would probably resist the pressure and cause a great deal of the deformations spoken of. His own practice was to build up sticks in the core, then to withdraw them and fill the space with silica sand. When the contraction began the silica sand would crush and fall away thus giving the casting the opportunity of contracting freely and keeping its shape in the mold till thoroughly cold, thus not causing any undue strains to be set up by sudden exposure to the air, while contraction had still to take place. The interior part of the drum of the flywheel was formed only of cores. He believed it was quite ordinary practice to build up the interior cores in that way. With regard to the distortion of the flasks in the ovens, they had overcome that trouble. They found that the flasks expanded in the ovens, and knowing that cast iron grew under heat treatment and never came back to its original size and that the sand contracted under the heat, it was obvious that the sand was smaller than the box; therefore the mold was smaller than was required and cores would not fit the prints prepared for them. He had overcome that difficulty by adopting a hot air system which reduced the expansion of the flask, the molds being dried on the floor, the heat being directed to the mold and not allowed to affect the flask. It had been suggested that steel castings should be taken out of the mold as quickly as possible and put into the annealing oven. But with cast iron that was not an easy matter, although it was true that they had to do this with chilled car wheels and work of a similar type. He had a system of leaving the casting in the mold as long as possible. In fact, the men at his place had nicknamed him "The Normaliser," because he advocated leaving the castings in the mold until they were normal or the casting was cold. They found that by leaving the casting in the mold they reduced the strains likely to be set up. Mention had been made of core irons growing in the ovens. He had found that these sometimes caused trouble and consideration should be given to this matter and irons made to offer as little opposition as possible to the tendency to grow and distort the core.

Mr. Brown, replying to the discussions, said he was glad the paper had raised so much interest. He was unable to agree with Mr. Watson as to the important part played by the sand as resistance and causing deformation He thought it was rather a matter of gravity and if a wheel was laid on the floor in a hot state it would not contract equally whether the casting was large or small. If they took a casting 4 feet square inside with a 2-inch square section and raised it to a white heat and laid it on the floor it would not contract perfectly. There would be no resistance except that of the atmosphere and gravity. Undoubtedly there was danger in connection with drying in the ovens because the flasks naturally got hotter on one side than the other. They were liable to deformation during the drying process. He entirely disagreed as to the safety of lifting castings out of the sand before they were cold.

A New High Temperature Cement

The Hausfeld Co., Harrison, O., manufacturer of nonferrous melting furnaces and other foundry equipment, is now producing a highly refractory cement adapted for patching and surfacing brick linings of melting furnaces, for lining ladles, etc. Tests made to ascertain the fusing point of this material indicated no loss of refractoriness until a temperature of 3002 degrees Fahr. was attained, which was the fusing point of a No. 26 Seger cone. This is equal to 1650 degrees Cent., a temperature greatly in excess of that required for the melting of nonferrous metals.

The E. H. Mumford Co., Elizabeth, N. J., manufacturer of an extensive line of molding machines, has removed its plant and main office to Dayton, O., and has changed its name to the Dayton Molding Machine Co.

Quantity Production of Simple Patterns Solved

Emergency Order for Flange Ring Castings for Riveted Pipe Demands Rapid Construction of Efficient Patterns for Quantity Production

By J L Gard

A WESTERN plant recently received a rush order for 22 flange and ring patterns for castings that were to be used on riveted steel pipe. The method used in making these patterns was simple and efficient and the finished product was satisfactory in every respect.

The first step was to saw out segments for the various sizes of rings. These segments were next tongued and glued together. The separate rings were then glued to the lathe face plate, one above another in a conical pile. When this operation was complete there were six ring patterns on each of two face plates, *B* and *C*, Fig. 1; six flange patterns on another face plate, *A*, Fig. 1, and three flanges and a ring on another face plate, *D*, Fig. 1.

The next operation was to complete the turned work. As each ring or flange was turned it was cut off with a parting tool; an extra allowance of stock having been provided for this purpose. After all the pieces were turned and cut off, the backs were finished smooth and parallel by hand planing to the circle that was obtained in the turning operation.

How the Bolt Holes Were Made

The bolt holes were next laid off on one pattern of each size of the flat rings. Three flat rings of each size had holes to match. These three were screwed together and the holes drilled on the drill press. The pieces were then taken apart and the holes reamed separately with a taper reamer to make allowance for draft. A special taper reamer was used for this purpose. To get the same diameter of holes in each case, the stop was set on the drill spindle to give the correct depth. Varnishing in the usual way completed the patterns. Fig. 2 shows a few of the completed patterns, *A* being flange patterns and *B*, ring patterns.

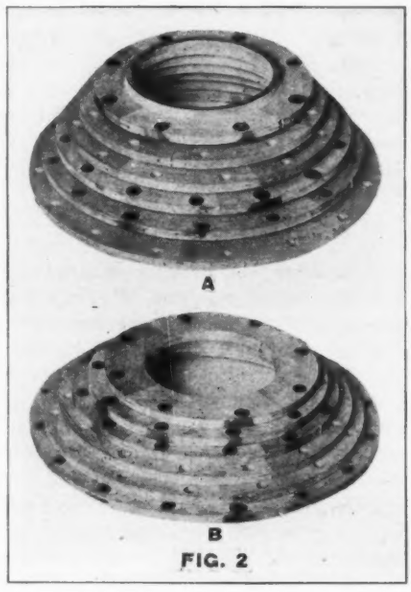


FIG. 2—FINISHED RING AND FLANGE PATTERNS

The method pursued in producing these patterns graphically illustrates how it is possible to save much valuable time by forming rough stock into units before beginning turning operations. Had each piece been turned and finished separately, it is obvious that much unnecessary time would have been consumed. In fact, had the one-at-a-time method been followed, the job would have cost twice as much as it did under the conditions described.

System Saves Much Time

It is my opinion that simple methods in the pattern shop prove to be the means of saving much valuable time and a glance over any pattern shop often reveals instances where production could be increased to quite an extent by planning jobs beforehand.

Taking the patterns described as an example; if these had been made one at a time the procedure would have been something like building a house by making one brick at a time, laying it in place and so on until the house was completed. Any journeyman patternmaker who has worked in several localities will agree with me when I say that better preliminary planning in making patterns is needed than is generally followed under present shop practice.

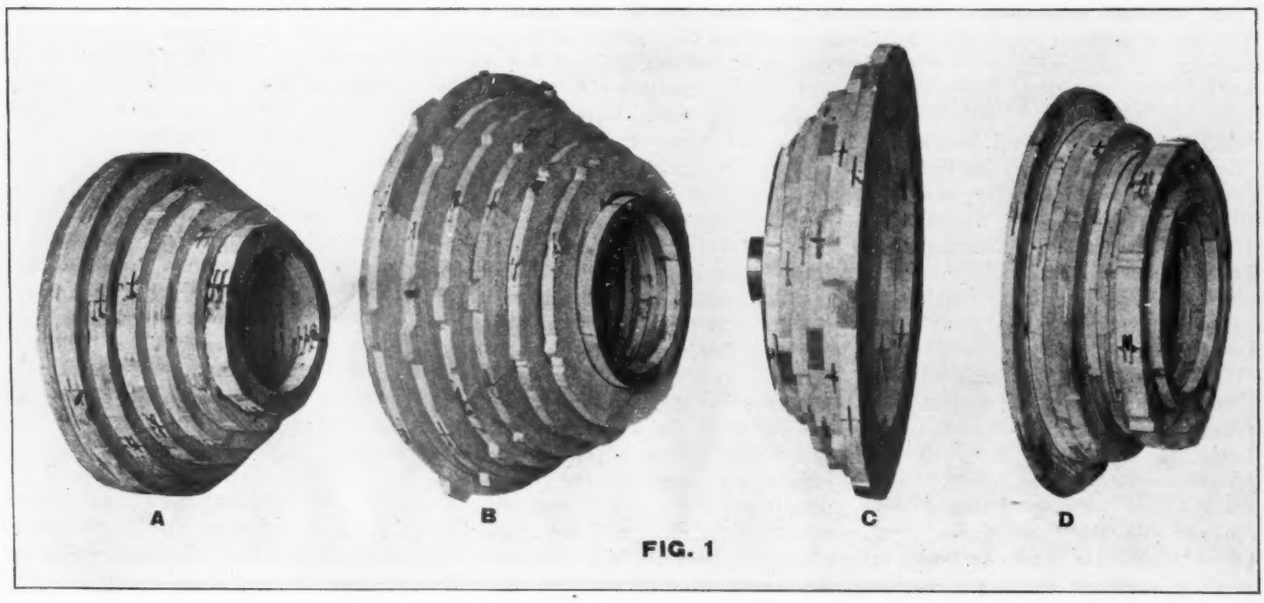


FIG. 1—SEVERAL RING AND FLANGE PATTERNS GLUED TOGETHER READY TO BE TURNED TO SIZE

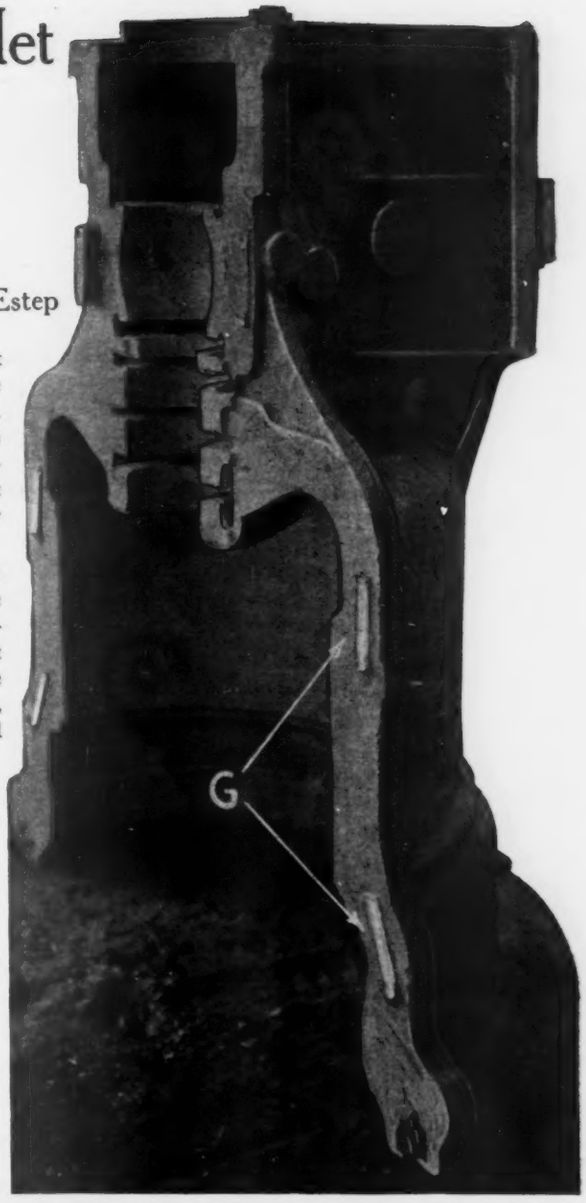
How One Steel Foundry Met the Need for Ship and Railway Castings

By H Cole Estep

AN interviewer recently asked a famous general, "What commodity is most needed to carry on the war?" He expected the answer would be either shells or food. It was neither. "Transportation," said the general, "is what the allies need most today. Perhaps," he added, "transportation is not a commodity. But it certainly is a service without which all of the commodities and men employed in waging war are valueless. It is the thing we need most."

Here in the United States the extension of all of our transportation facilities, both by sea and land, is as vital to the prosecution of the war as the manufacture of artillery or ammunition. We must have an endless number of ships and a vast quantity of new locomotives and railroad equipment if we are to win. In the production of both ships and railroad equipment, a heavy burden is laid on the steel foundries which are called upon to furnish a large number of castings for rudders, rudder posts, turbines and other ship-propulsion equipment, as well as for driving-wheel centers, locomotive sideframes, running-gear parts, etc.

At the present time a number of large steel foundries are devoting almost their entire energies to the manufacture of ship-propulsion and railway equipment. Prominent among the works in this category is that of the Birdsboro Steel Foundry & Machine Co., Birdsboro, Pa. Situated in the heart of the coal and iron region of eastern Pennsylvania, this plant is unusually well located for the character of work upon which it is engaged and its equipment, which has been developed, enlarged and improved gradually for the past several years, is well adapted to the task at hand. The Birdsboro company operates a machine shop, gray-iron foundry, roll foundry and an open-hearth steel foundry. The latter has been recently extended and its capacity considerably enlarged. Its equipment



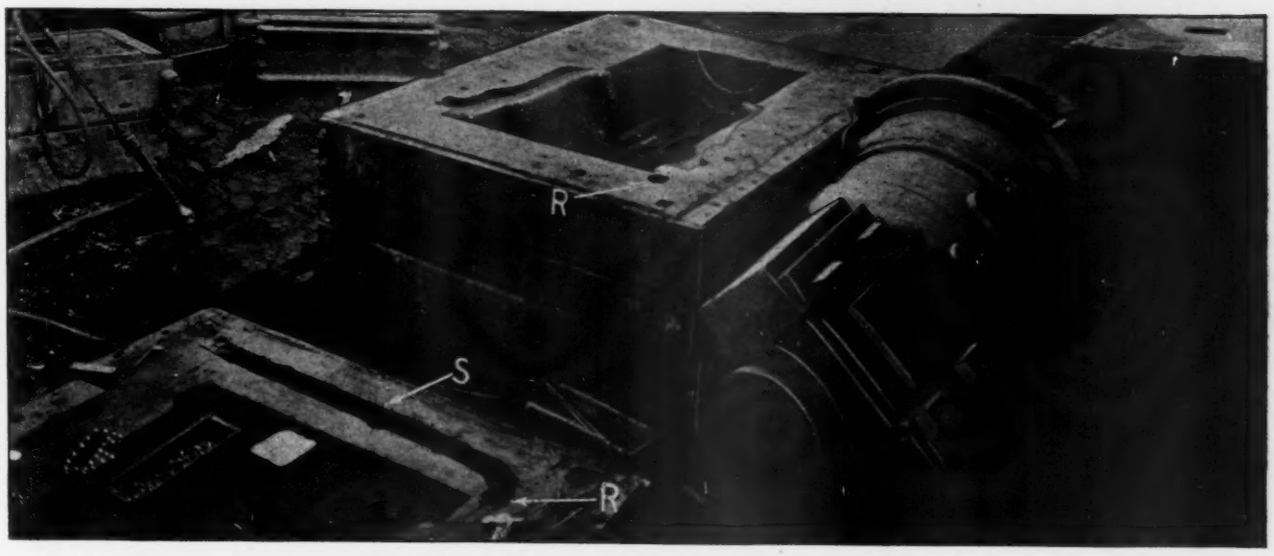


FIG. 1—GENERAL ARRANGEMENT OF MOLD AND PATTERN FOR STEEL TURBINE CASINGS FIG. 2—STEEL TURBINE CASING CASTINGS READY FOR SHIPMENT TO MACHINE SHOP

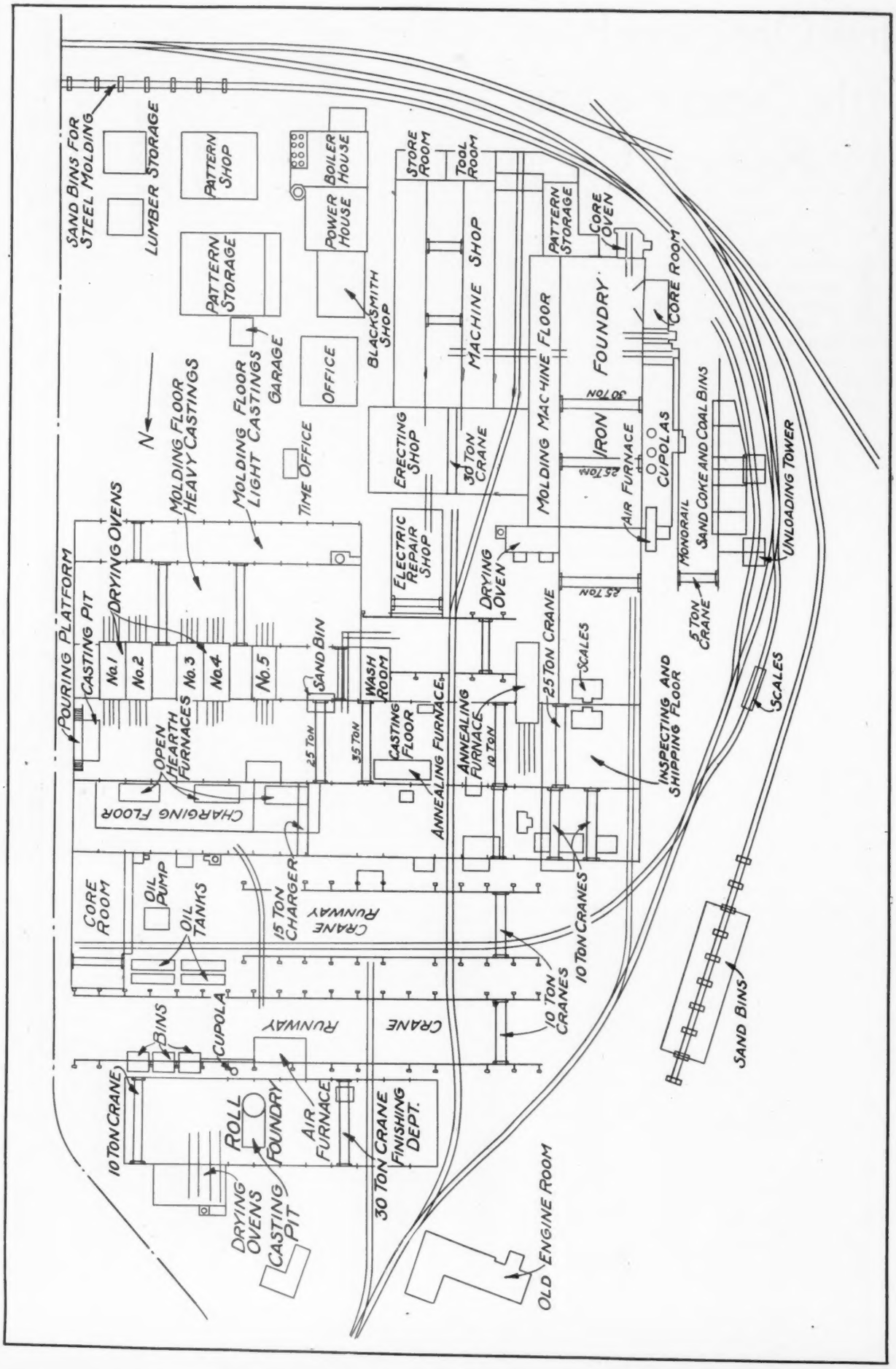


FIG. 3—GENERAL ARRANGEMENT OF WORKS OF BIRDSBORO STEEL FOUNDRY & MACHINE CO.

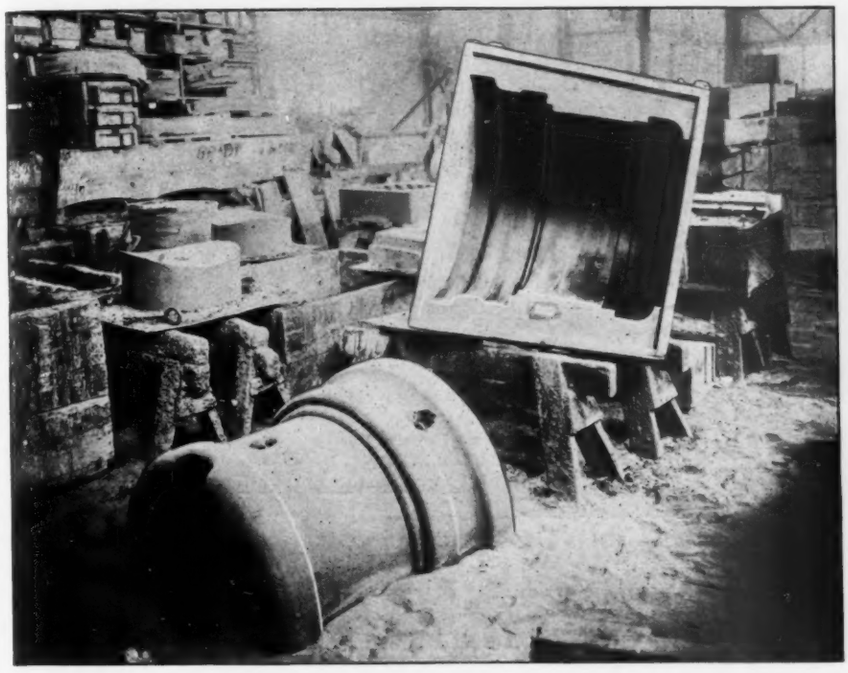


FIG. 4—A SOLID WOODEN COREBOX IS USED FOR MAKING THE LARGE CENTRAL CORE FOR TURBINE-CASING MOLDS

today includes three 30-ton oil-burning acid stationary open-hearth furnaces, five 20 x 45-foot coal-fired mold-drying ovens, one oil and two coal-fired annealing ovens, 12 electric traveling cranes ranging from 2 to 35 tons capacity, together with the necessary auxiliary equipment for making molds, melting metal and handling material. The steel foundry has a molding floor area of approximately 31,000 square feet. The output ranges from 80 to 100 tons per day. Practically all of this material is going directly or indirectly into war work. A large number of steel and iron turbine casings, steel stern castings, locomotive driving wheel centers, sideframes, etc., are turned out at the Birdsboro plant.

The recent extensions to the steel foundry, which are indicated by Fig. 13, include a building 135 feet 3 inches in length and 60 feet in width, connecting the finishing end of the steel foundry with the gray iron foundry, together with 70-foot extensions on the pouring and furnace bays on the old steel foundry structure. These extensions add considerably to the pouring floor area and also to the cleaning and shipping facilities.

How Molding Sand is Stored

Coincident with the enlargement of the steel foundry, the molding sand storage and handling facilities have been improved. A new set of concrete sand bins has been erected on one corner of the property. These bins, six in number, have an aggregate capacity of eighteen 50-ton carloads. Their general arrangement is shown in Fig. 6. They are of solid concrete construction, each bin being 20 feet in length and of approximately corresponding width and height. The bins are arranged in the form of a trestle with a railroad track over the top on which the incoming shipments are received. The hatchways in the deck of the trestle through which the sand is unloaded are 2½ x 12 feet in size.

In the production of castings such as those now being turned out at the Birdsboro plant numerous interesting molding problems are encountered. This is particularly true of the marine work with which the American foundrymen are generally less familiar than with railroad work or other old established lines. The turbine casing shown in Fig. 2 is typical of the class of marine machinery castings now required of American steel foundries. Figs. 1, 4 and 5 show how this casting is molded at the Birdsboro plant.

Eyebolts Aid In Handling

Fig. 4 shows the arrangement for making the large central core in the steel foundry coreroom. On account of its size and weight, this core is provided with eyebolts, which permit of its being readily handled by means of a crane. A solid wooden core box is provided in which the sand is rammed by hand, one man and a helper being employed. The core is heavily rodded and thoroughly tied together with strong wires in order to give it the necessary strength and rigidity. In addition to the large central core, eight smaller cores are required for molding the turbine casing shown in Fig. 2. These smaller cores are hand-rammed in core boxes in the ordinary manner.

The department in which this core work is performed adjoins the main steel foundry behind the open-hearth furnaces. The room, which is 20 feet wide and 100 feet in length, is served by a 2-ton traveling crane. A coke-fired, car-type oven has been provided for drying the cores. When the cars come out of the ovens they are picked up by the crane and deposited at the most convenient point in the shop for

FIG. 5—DRAG FOR TURBINE-CASING MOLD SHOWING ARRANGEMENT OF GATES AND GUIDE PIN FOR CLOSING FLASK

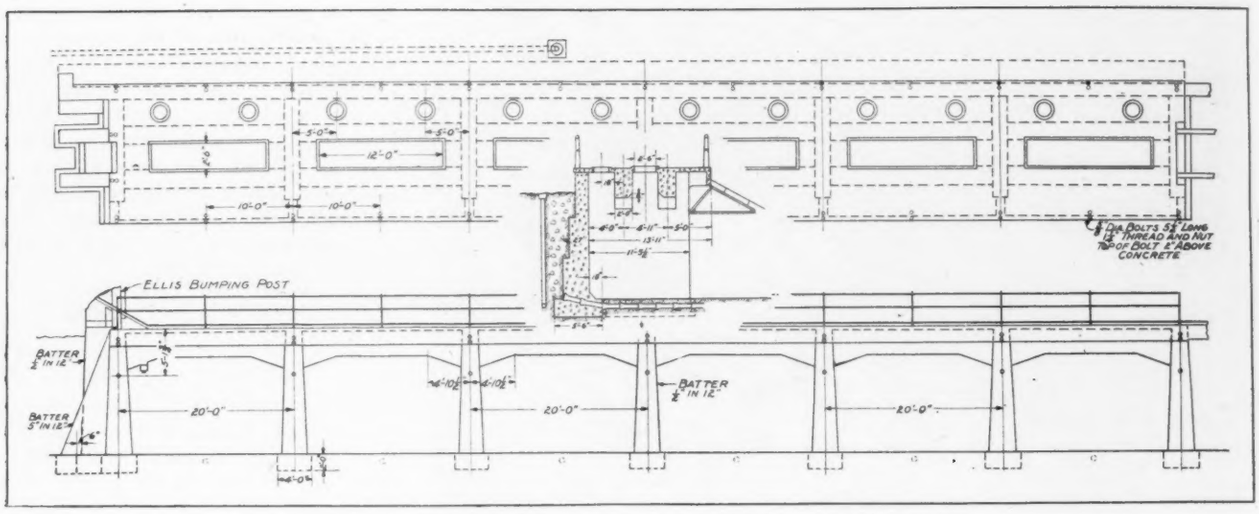


FIG. 6—CONCRETE TRESTLE BINS FOR STORING SAND AND COKE

unloading. The cars are similarly handled by the crane for loading.

The molds for small turbine casings are made in a 3-part flask, as indicated in Fig. 1. The inside dimensions of the flask are 5 feet 11 inches x 7 feet 11 inches. The cope is 12 inches, the cheek 20 inches and the drag 12 inches in depth. Bolted, sectional cast-steel flanks are used. Most of the mold is in the cheek. The cope serves simply as a cover and the drag as a base. The casing is made in halves and a solid pattern, shown in Fig. 1, is employed. The prints for the five risers are clearly shown on the pattern. Four of the risers are attached to the body of the casting and one to the flange on the bell end. The former are 3 x 6 inches and the latter 3 x 8 inches in cross-section.

The metal enters the mold through a runner extending through one corner of the cope and cheek as shown at *R*, Fig. 1. The same reference letter is also used to show where the runner terminates in the drag. A more complete view of the drag, with the sprue extending nearly across the full width of the flask at the rear, is shown in Fig. 5. This sprue is also shown at *S*, Fig. 1. The metal enters the mold at the bell end through gooseneck gates of the bottom-pour type. These gates are attached to the flanges of the castings, as shown at *G*, Fig. 2.

Instead of using flask pins of the ordinary type, cast-steel pegs of pyramidal shape are inserted in the sand at the four corners of the drag. These pegs are clearly shown in the foreground and also in the rear in Fig. 5. When the molds are dried, these guide pegs are firmly fixed in place. They fit into corresponding recesses in the sand in the cheek and have proved entirely satisfactory in insuring a proper register between the different parts of the flask.

The foregoing description gives a general idea of the method employed in attacking and solving intricate molding problems at the Birdsboro plant. A large proportion of the castings are exceedingly complicated, similar to the turbine casing just described. In all work of this nature, difficulties of course are encountered in the way of unequal shrinkage strains set up in the casting while the metal is cooling. These strains may be very largely overcome by giving thought to the distribution of metal in the neighborhood of abrupt changes in section and also by the

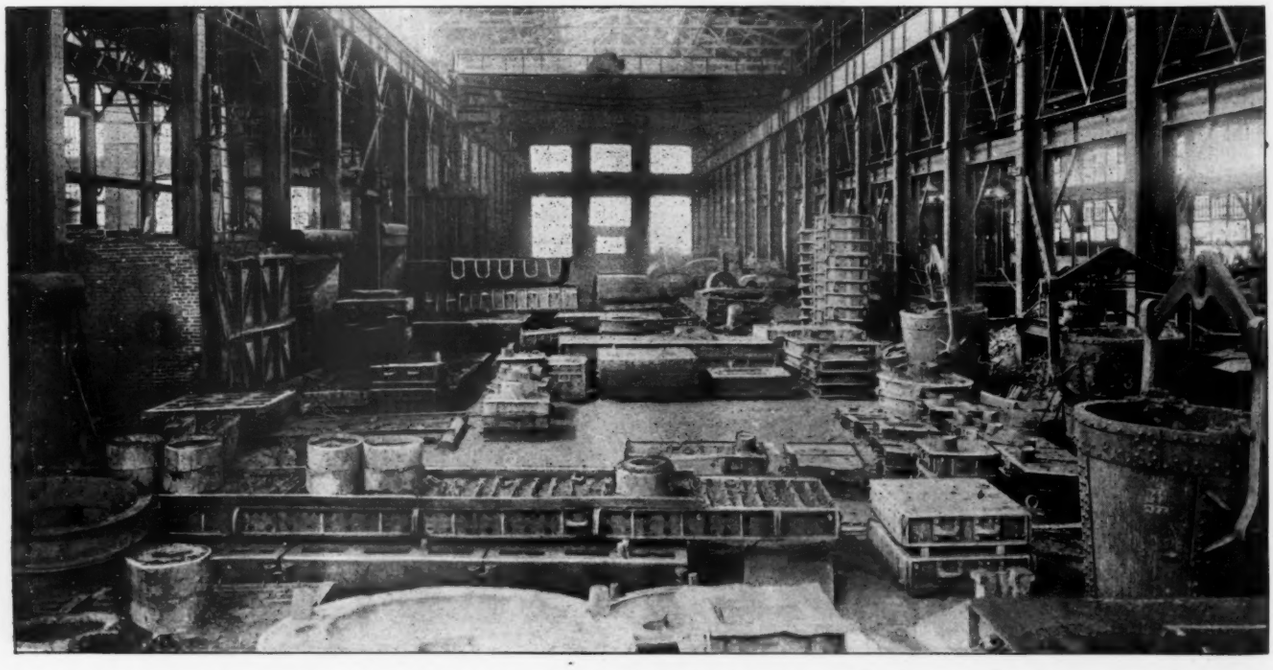


FIG. 7—GENERAL ARRANGEMENT OF POURING FLOOR SHOWING DRYING OVENS ON THE LEFT AND OPEN-HEARTH FURNACES ON THE RIGHT

FIG. 8—COAL-FIRED ANNEALING FURNACE WITH ROOF COMPOSED OF REMOVABLE BUNGS

judicious use of chills in the mold. The latter phase of the problem is given special attention at the Birdsboro plant, and an unusual effort is made to use chills in an efficient manner.

On most of the work, also, highly skilled molders are employed and these men have learned how to ram complicated jobs so as to counteract the effect of expansion and contraction, at least to a degree.

In this connection it may be stated that an effort is made to maintain a high standard of workmanship throughout the entire plant. The employes are selected with great care and the working conditions are such that steady employment is encouraged. The labor turnover of the Birdsboro Foundry & Machine Co. is relatively low and the large proportion of English-speaking employes in the plant is also noteworthy.

Close attention is given to the problem of maintaining proper standards in the preparation of facing sands. All the facings in use are under the constant scrutiny of experts. The facing sand employed for molding turbine casings and other castings of similar character has the following composition: Yellow sand, 30 parts; white sand, 20 parts; old sand, 30 parts; crushed silica rock, 10 parts; sawdust, 5 parts; and pitch 4 parts. The yellow sand averages 94 per cent and the white sand, 98 per cent silica. The facing is prepared in a mixer of the muller type. The old sand is carefully screened and passed through a magnetic separator before being reincorporated.

One of the functions of the old sand is to stabilize the moisture content in the mixture, since the moisture contained in the white and yellow sand varies from time to time. Experiments are also under way looking to the stabilization of the moisture content by other means. The question of binders also receives constant consideration, and at the present time experiments are being made with various types of prepared binders, which it is thought may supplement the binding qualities of the clay naturally occurring in the sand.

On all government work the heat number must appear on every casting. On most of the work at the Birdsboro plant these numbers are stamped in the mold just before it is sent to the drying oven. Serial numbers also are placed on the castings in the same manner when necessary. On work for the war and navy departments, the usual

FIG. 9—GENERAL ARRANGEMENT OF HEAVY MOLDING FLOOR WITH DRYING OVENS IN THE BACKGROUND

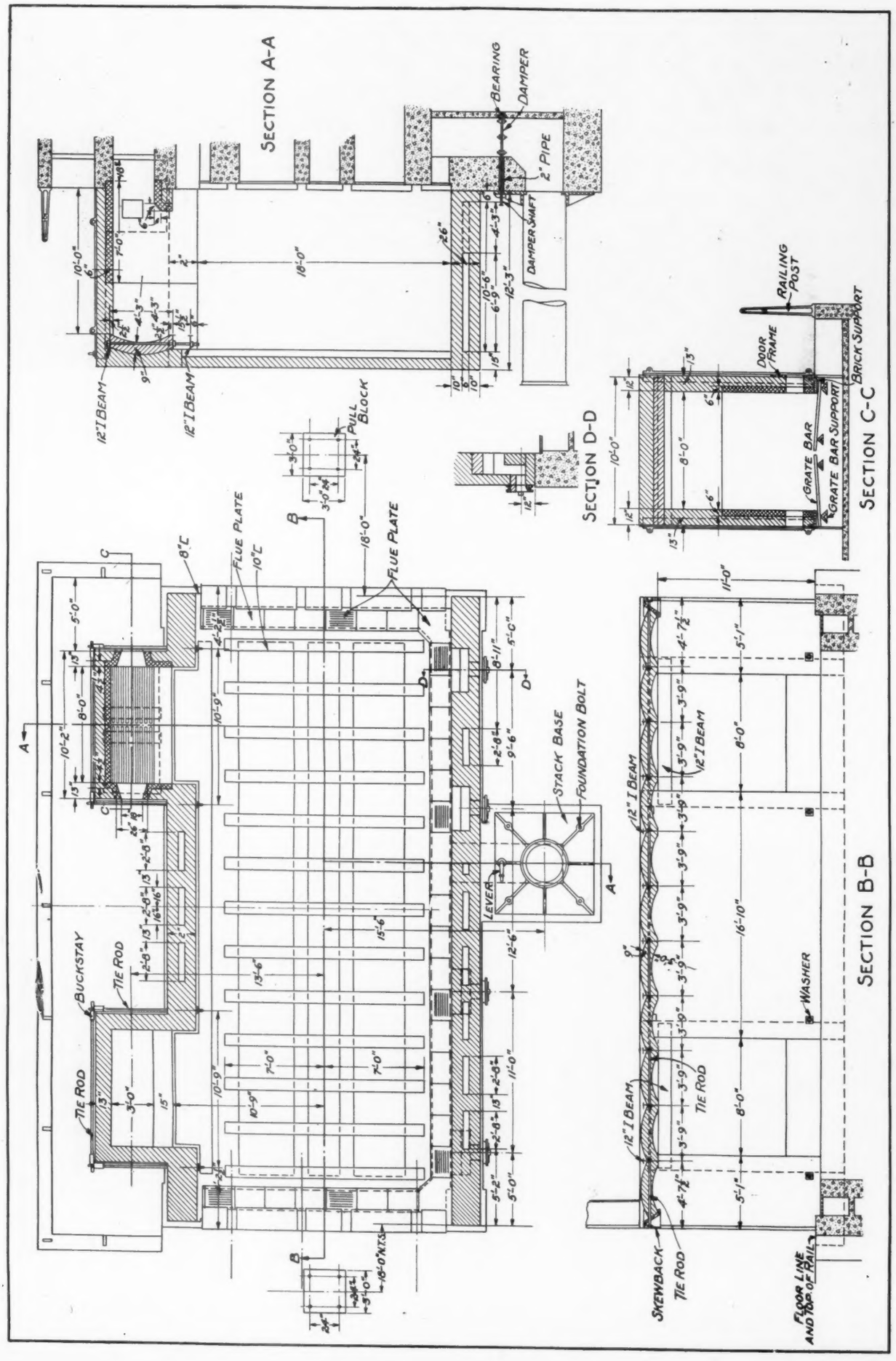


FIG. 10—DETAILS OF MOLD-DRYING OVEN SHOWING ARRANGEMENT OF FIRE BOX, FLUES, ROOF CONSTRUCTION, ETC.

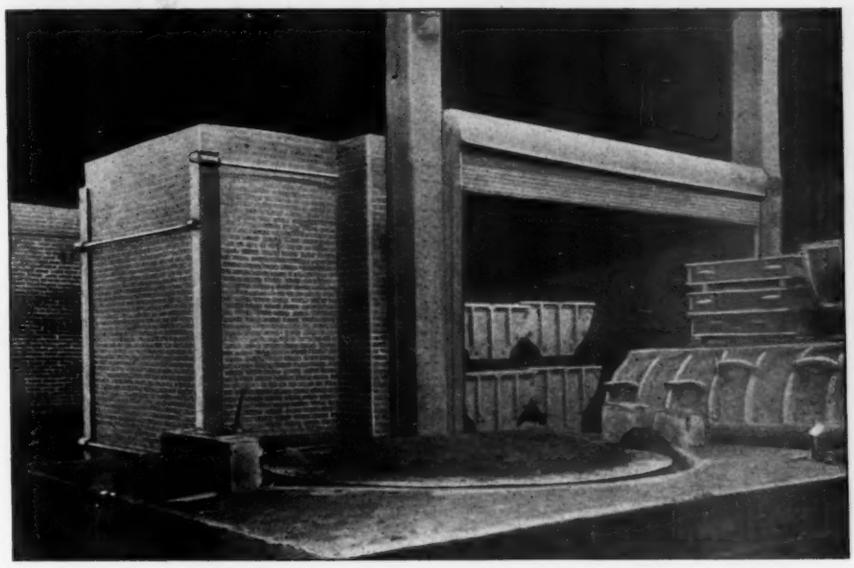


FIG. 11—DOUBLE-ENDED COAL-FIRED DRYING OVEN

government inspection methods apply, including inspecting the castings in the green prior to annealing. Each casting must be inspected and passed individually regardless of its size or importance.

Oven-Dried Molds Used Extensively

Practically all of the work handled in the steel foundry of the Birdsboro Steel Foundry & Machine Co. is made in oven-dried molds. Extensive drying equipment has been provided for this purpose including five large double-ended, coal-fired ovens, one of which is shown in Fig. 11. As shown in Fig. 3 these ovens occupy a 40-foot bay situated between the molding and pouring floors, the ovens being so arranged that the green molds entering at one end are discharged at the other directly onto the pouring floor, where they are finally disposed of by means of the pouring-floor cranes.

The drying ovens have many interesting features, several of which are indicated in Fig. 10. They are amply proportioned, each one being 43 feet in length, 18 feet in width and 11 feet in height inside. They are each traversed by two standard gage tracks. There are, therefore, 86 feet of trackage in each oven. The ovens are arranged with the fire box on one side and the chimney on the other, as shown in Fig. 10. The various flues are distributed so as to heat the ovens as evenly as possible. The fire boxes are double-ended with a grate of 24 square feet. The fire boxes are unusually high, the distance from the top of the bridge wall to the springing line of the fire-box arch being approximately 9 feet. The oven roofs are of arched construction supported by 12-inch I-beams spaced on 3-foot 9-inch centers. The general arrangement of the drying ovens and the heavy molding floor in the steel foundry is shown in Fig. 9.

The three 30-ton acid open-hearth furnaces with which the shop is equipped are located alongside the pouring floor as shown in Fig. 3. The furnaces are flanked by an ample charging platform 53 feet in width and 190 feet in length. The open-hearth stock yard, which is served by a 10-ton crane, lies parallel to the charging floor. At present the furnaces are charged by hand. Work is going forward, however, on the construction of a 15-ton crane-type charging machine, which will be built in the Birdsboro company's own shops. When this crane is installed, cast steel charging boxes of the standard type, 4 feet 6 inches in length, will be employed. The boxes will be loaded in the open-hearth stock yard and brought under the charging floor crane by means of cars operating on a short narrow gage track. The buggies, carrying the loaded boxes, will then be picked up bodily by this crane and deposited on the charging track extending behind the furnaces.

The open-hearth furnaces, which are of the oil-burning type, were built by W. H. Holcroft & Co. The hearth is 18 feet in length and 10 feet in width. The arrangement of the buck stays, which are cast steel, are shown in Fig. 12. This illustration also shows the oil-burning apparatus clearly and the arrangement of the three charging doors.

Oil burners of a standard type are utilized. The oil is delivered to the burners under a pressure of approximately 40 pounds per square inch. The compressed air, with which the oil is atomized, is delivered to the furnace at approximately 60 pounds per square inch. In addition to the holes for the insertion of the oil burners, four peep holes are provided at each end of the furnace. This enables the melter to obtain a clear, unobstructed view of the operations within the furnace. The air valves are reversed every 15 minutes, thus maintaining a uniform temperature.

A Typical Charge

On account of the importance of the work handled, it is necessary to give close attention to the metallurgical operation of the furnace. The charges are carefully proportioned to produce castings of the desired composition. Inasmuch as the furnace is acid-lined, no effort is made to refine the charge. Castings of widely varying compositions are made and a number of furnace mixtures are employed. A typical charge for work such as turbine casings, etc.,

FIG. 12—THIRTY-TON OIL-BURNING ACID-LINED STATIONARY-OPEN-HEARTH FURNACE

FIG. 10—DETAILS OF MOLD-DRYING OVEN SHOWING ARRANGEMENT

FIG. 13—THE NEW EXTENSION IS MODERN IN DESIGN AND CONSTRUCTION

and the roofs should last approximately 800 heats. It is felt that oil has a number of advantages in melting and arrangements are now being made to remove a battery of gas producers which were used at one time. The fuel oil is stored in four 12,000-gallon tanks, located conveniently alongside a spur track behind the furnaces. The oil is delivered to the furnaces by means of two electric pumps.

Extensive annealing equipment is required in a plant such as that operated by the Birdsboro Steel Foundry & Machine Co. Two annealing furnaces are now in service and a third is under construction. One of the old furnaces, which is of rather novel design, is shown in Fig. 8. It is 9 feet wide, 40 feet in length and 7 feet in height. This furnace is roofed over with bungs similar to those employed in air furnaces. When the furnace is charged

is as follows: Low phosphorus pig iron, 5000 pounds; boiler plate clippings, 15,800 pounds; old couplers, 6390 pounds; old forgings, 9810 pounds; ferromanganese, 280 pounds; ferrosilicon, 195 pounds; and sand, 100 pounds. A heat such as this is charged in about 3¾ hours and from 5¾ to 7 hours elapses from the time charging begins until the metal is tapped.

The metal in the foregoing heat analyzed as follows: Carbon, 0.30 per cent; manganese, 0.45 per cent; silicon, 0.20 per cent; sulphur, 0.033 per cent; and phosphorus, 0.028 per cent. This steel when properly treated shows an elastic limit of approximately 39,000 pounds per square inch, and a tensile strength of 70,000 pounds, together with an elongation of 15 per cent and a reduction of area of 20 per cent.

Operating on the basis just described, the furnace consumes from 42 to 45 gallons of oil per ton of metal charged

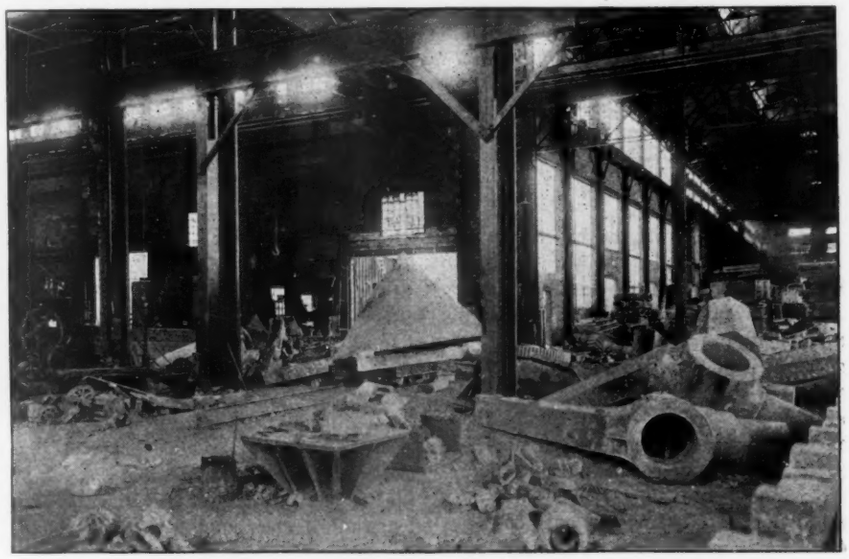


FIG. 15—INTERIOR OF NEW EXTENSION, SHOWING L-SHAPED STRUCTURE WITH IRON FOUNDRY AT THE RIGHT AND STEEL FOUNDRY AT THE LEFT

FIG. 14—VIEW OF IRON FOUNDRY, SHOWING ARRANGEMENT OF CUPOLAS, STOCK YARD AND MONORAIL

the bungs are removed and the castings dropped into the annealing chamber by means of one of the traveling cranes. In addition to this furnace, a small car-type oil-burning annealing furnace has been installed in one corner of the shop as shown in Fig. 3. This furnace is 8 feet in width, 16 feet in length, and 4 feet in height inside, the height being measured from the car platform. A hydraulic straightening machine is installed alongside this furnace. The new coal-fired annealing furnace will be 48 feet long, 8 feet wide and 4 feet 6 inches high. It will be of the car type and will be installed in the new steel foundry building extension.

The cleaning and chipping department, which has been considerably enlarged by recent new construction, occupies a floor space of approximately 12,000 square feet. It is adequately equipped with scales, cranes, pneumatic chipping

hammers and other apparatus for putting the final touches on castings. The floor level of this department is about 6 feet below that of the gray iron foundry, which it adjoins. The boundary between the two shops is marked by a concrete retaining wall and when necessary, advantage is taken of this difference in elevation for pouring heavy molds, the top of the retaining wall serving as a pouring platform. In addition to the steel foundry, the Birdsboro company has recently completed or is contemplating extensive improvements to its gray iron foundry, roll foundry, machine and erecting shops and to the various auxiliaries throughout the plant. In every case the object of these improvements is to increase capacity and improve efficiency through the installation of modern labor-saving devices. The officers of the Birdsboro Steel Foundry & Machine Co. include Robert R. Brooke, president; George Brooke, vice president; Leon E. Thomas, vice president and general manager; and E. Owen Brooke, secretary.

How to Make a Pattern for a Furnace Door

By M E Duggan

WHILE employed in the pattern shop of a large foundry making a general and special line of castings for boiler fronts, doors, door frames, grates, wall anchor plates and similar castings used in the construction of steam boilers, muffles and furnaces, I had an excellent opportunity to see and study the various ways and methods followed by patternmakers in making patterns for such castings.

The brick lined furnace door shown in the accompanying illustration is a good example of some of the methods followed by patternmakers in making a pattern for such parts. To simplify the illustration I have shown three methods used by three different patternmakers.

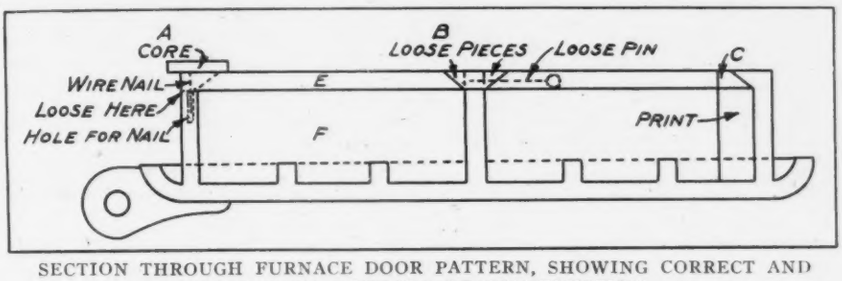
Molding Difficulties

The design is of the box door type having on its inner edges projecting lips which form pockets into which the brick lining is anchored in place. These lips are the cause of much guesswork and worry for the patternmaker who does not understand the best molding practice.

The slab core method *C* is not impractical because this method calls for material, labor and time in making the cores, fitting, setting and anchoring the cores in the mold and a possibility of the core being forced into the mold space by the metal working in between the green sand and the core. This method is contrary to good molding practice and patterns made in this way are often rejected by the foundry.

With the loose lip method *B*, the strips are cut in short sections, intended by the patternmaker to be drawn up and out of the mold through the narrow vertical pockets left in the sand after the pattern is removed. This idea of molding is common among patternmakers. If they will follow the pattern to the foundry and observe the work of the molder, they will see that instead of lifting the loose pieces up through the spaces or pockets, the molder will proceed to fill in the sand up to the top of the pattern after which he will pick out the loose pieces and place a slab core over the spaces left after the removal of the loose pieces. Next, the sand is filled in and the drag half of the mold is completed and ready to be rolled over to receive the cope.

The molder has had all of these loose pieces to contend with in placing them in their correct positions on the body of the pattern. A possibility also exists of the loose pieces shifting in the mold after the pins are withdrawn. Again, the loose parts or the wire pins that hold them in place are often lost, either in the foundry or in the pattern storage loft.



SECTION THROUGH FURNACE DOOR PATTERN, SHOWING CORRECT AND INCORRECT METHODS OF CONSTRUCTION

While a casting can be produced from a pattern made in this way, the method is not best adapted to meet the needs of the molder.

My experience with this class of patterns, and with the molding of such castings, leads me to conclude that a large number of patternmakers do not understand the purpose of the cover core and how and where it can be used. Method *A* is a good example.

Pattern in Two Pieces

The pattern is in two pieces, frame *E* and body *F*. Frame *E* is a solid piece and is loosely fitted with wire dowel pins to the body *F*. No core prints are used. Sand is first filled in up to the top of the frame, then the filling-in is stopped, the sand is struck off even with the top of the pattern and the frame *E* is lifted. Next the slab or cover cores are set over the openings in the mold as shown at *A*. The filling-in of the sand is now continued and the mold is finished and rolled over to receive the cope.

Coating Iron Castings With Lead

By E. P. Later

Question—What flux is used for coating iron castings with lead?

Answer—To my knowledge no flux is in existence which will facilitate the coating of iron castings with lead. Lead, unlike zinc, does not alloy readily with iron in the ordinary hot-dip process. Many attempts have been made to develop a satisfactory method for obtaining lead coatings in this way, and on certain classes of work some success has been reported. By the Lohmann process, for example, wrought iron and steel can be more or less successfully coated with lead, or a lead alloy, through the use of special fluxes of secret composition, although such samples as I have examined did not show up very well. Cast iron, however, is more difficult to treat than wrought iron and no one has yet succeeded in giving such parts a satisfactory coating of lead in a commercial way. It is possible, however, that iron castings may be coated with a lead-tin alloy approaching the composition of ordinary solder, although the high price of tin might make this process too expensive. The only other suggestion I can make is that the Schoop process be tried. By this method lead or any desired metal is sprayed in the molten state onto the parts to be finished permitting coatings of any given thickness to be produced.

Standards for Protective Finishes for Iron

Results of an Interesting Series of Tests Are Presented, Which Indicate the Protective Qualities of Various Metals and Thicknesses of Coatings

By E P Later

IT is no secret, military or otherwise, that enormous quantities of war supplies of every description are being turned out in thousands of factories all over the country and the production of these has given point and emphasis to the need of greater standardization and more definite requirements in the matter of protective finishes, a subject which has of recent years been attracting considerable attention. Military equipment is subjected to the most severe conditions of exposure and service, nevertheless the metal parts of airplanes and of a whole host of other appliances and instruments must be given as thorough protection from corrosion as possible, for very obvious reasons. Now, as every plater and engineer knows, there is a good deal of diversity of opinion regarding the best protective coating for iron and steel; the best method or solution for producing this; the minimum weight or thickness consistent with the desired amount of protection; and, finally, the best way of testing metal finishes in order to determine easily their worth and suitability.

To some of these questions it is rather difficult to give a categorical answer, but at the conference on electro-plating, held in the latter part of March at the Bureau of Standards and attended by representatives of the manufacturers, the military authorities, and others interested in the plating industry, some of these points were discussed pro and con and much was accomplished in the way of arriving at a definite decision in regard to them. Inasmuch as many of these questions are of more than passing interest to the plater and others engaged in similar work it may be helpful to discuss some of them briefly.

Metals For Protective Coatings

A number of metals, copper, zinc, brass, nickel, etc., are available for use as protective coatings for iron and it is often necessary to decide which one of them should be used on a certain part. At first sight it might appear, and an old plater once assured me that it is really true, that one metal is as good as another and there should not, therefore, be much choice. If we consider, however, some of the facts regarding the corrosion of iron and steel and the conditions which must be attained in order to prevent its occurrence, it will be possible to attack the problem more intelligently.

Briefly, the corrosion of iron is attended by the evolution of hydrogen and other evidence of electrolytic action and the electrolytic theory of rusting holds that corrosion is accompanied by a flow of current from the points of high potential to those of low potential, or from electro-positive to electro-negative poles. It can be shown that every iron surface tends to develop points of opposite polarity and further, that in the presence of conditions favorable to corrosion, the points or spots which are electro-negative are protected at the expense of the electro-positive spots, which are corroded rapidly, a current flowing meanwhile from the latter to the former. This may be made somewhat clearer by roughly comparing this action to that which takes place in a plating tank. In the latter the current flows from the anode, electro-positive, to the cathode, electro-negative, and the anode is dissolved while the cathode is protected.

Theory of Electro Action

With this in mind, it should be easy to see that if we can combine or join the iron with some metal which is strongly electro-positive to it and then expose such a couple to air and moisture, a current will flow from the more positive metal to the iron, with the result that the latter will be protected while the other will suffer in some way.

This is precisely what takes place when iron is coated with zinc. This metal is quite strongly electro-positive to iron; so when in the course of time a zinc coating breaks down and allows air and moisture to reach the iron, a current is set up and flows from the zinc to the iron, which is thereby protected. There are other metals which are just as electro-positive, or more so, to iron than zinc, but they are not adapted physically for use as protective coatings; therefore zinc has no rivals along this line. This does not mean that a coating of this metal is perfect or lasts indefinitely under all conditions; it must be remembered that it protects the iron by virtue of the fact that it itself is oxidized and destroyed; therefore it is plain that such a coating will eventually become so thin and disintegrated that it will no longer exert any protective influence and corrosion of the underlying iron will take place. With a coating of liberal weight many years would be required to bring about this condition, under any ordinary exposure.

Physical Protection

On the other hand, copper, nickel and the remainder of the metals which are commonly applied to iron as a protective coating act merely as a more or less impervious covering to prevent air and moisture from reaching the surface of the iron. Broadly speaking, they preserve the iron in about the same way that lacquer and japan do, by exclusion of the things which produce corrosion; there is no protection electro-chemically.

In view of these facts it is only natural that zinc should be considered to give the best protective coating and its use ordered whenever the long life of the parts and the greatest possible freedom from corrosion are of importance, even though the conditions of exposure and service may be very severe.

It is one thing, however, to specify that parts be plated or otherwise coated with zinc, but an entirely different matter to say how much zinc we want, and on this point there has always been a good deal of confusion. I have seen orders which called for a "heavy nickel plate," or similiarly in the case of copper or silver, or any of the metals ordinarily used for protective coatings, although events showed that neither the purchaser nor the manufacturer had any idea whether a heavy nickel deposit was 10 milligrams or 75 milligrams per square inch, on a weight basis, or 0.0001 or 0.001 inch thick.

Tests, such as the copper sulphate or Preece test, for zinc coated parts, have been worked out and are in use as a means of obtaining roughly the

approximate thickness of a protective coating, by noting the length of time required to remove it by certain reagents acting under certain conditions; in many ways they no doubt serve a useful purpose, but there are many factors affecting the value of their results and at best they give only some idea as to the minimum thickness of the coating. They afford little or no definite information regarding the porosity of the deposit or its actual thickness or effective weight.

In many establishments it is the practice to plate the parts for a certain length of time, one hour for example, on the assumption that a deposit produced under these conditions will meet all of the requirements. Perhaps it will, but to say that a part has been plated for so many minutes or hours means almost nothing unless the amperage, number of square feet of plating surface, etc., are known. Otherwise it would be necessary, therefore, to determine by chemical means the weight, or by exposure tests the actual behavior, of the deposit produced under the given conditions if anything like accurate data are to be had. Without this a manufacturer runs a great risk of either putting on too thin a coating, with the result that his product will be deficient in wearing or rust-resisting qualities, or of applying a deposit which is more or less greatly in excess of the requirements, with consequent unnecessarily high finishing costs and lowered output.

Standard Weights Demanded

There has been some agitation among plating experts for the establishment of definite, standard weights of deposit and there is no doubt that something of this sort would be a highly desirable and advantageous thing and would tend to eliminate the trouble caused by the present deficiencies in this respect. There are, of course, at least two ways of going about the matter. We can put our requirements on a weight basis, knowing by experience or experiment that so many milligrams of deposit per square inch will successfully withstand a certain amount of exposure or service; or we can apply what are in effect greatly accelerated corrosion tests, on the principle that if the parts under consideration can withstand such a test or tests for a certain length of time they will be able to meet the conditions encountered when in use.

While I personally have always rather favored the former procedure, for reasons which need not be detailed here, there is no doubt that the other will, when properly carried out, give satisfactory results and in some ways probably possesses certain advantages over the first one. In any event, it was decided at the Bureau of Standards' conference on electro-plating that zinc coated parts shall be capable of withstanding for a specified length of time the corrosive action of a strong salt-water spray, thereby making this test, which has been in use for some time, the standard for use on at least certain classes of exacting government work.

Platers and engineers often find it necessary to provide a finish for ironwork of one sort or another which is exposed to severe conditions and the problem of protecting it sufficiently is of considerable importance. Painting or japanning may frequently be employed, but when these are unsuitable, recourse must be had to some plated coating. Copper, nickel and so on are satisfactory enough for parts which are not exposed out-of-doors, but it is a matter of common observation that thin deposits, particularly, of any metal with the exception of zinc fail to protect iron for very long under severe conditions; nevertheless, it is often desired to give certain parts a bronze, copper or nickel finish, for the sake of appearance. The fact that such coatings are usually not very satisfactory leads to the conclusion that the deposits of the weight or thickness ordinarily applied are porous and allow moisture to penetrate through to the iron, with consequent more or less serious rusting.

The results, therefore, of some experimental work which was carried out some time ago by Prof. Watts on the protective value of coatings of varying weight should be of interest to all who have to deal with questions of this sort. It may be said, incidentally, that often there is not only a lack of knowledge among platers and technical men regarding the thickness or weight of deposit which is applied to plated work, but information as to the minimum amount of metal that can be safely applied in order to meet different conditions of service may be either extremely vague or practically nonexistent, with the result that this side of the question is, to all intents, ignored.

Amount of Metal Deposited

It is true that in many places it is the practice to specify the amount of metal to be deposited on at least certain of the products; in some instances this is varied to correspond roughly with the conditions to which the parts are to be subjected, that is, parts intended to be placed out-of-doors or in very damp or exposed places will receive a deposit which is two or three times as heavy as that given to parts which are not required to withstand as severe service conditions, but in several instances which have come to my attention this sort of thing was guesswork, pure and simple.

Coming back to the experimental work mentioned, sample strips of steel were cleaned and weighed, then plated for varying periods with zinc, copper, nickel and brass, and weighed again. From the data thus obtained the thickness of the deposit, or its weight per square inch could easily be calculated. The samples were then placed in suitable racks and exposed to the weather, to determine the protective value of the coating.

Results of Tests

Under the conditions of this test thin copper deposits, 0.00027 inch thick, allowed very serious rusting to take place in two weeks; with a deposit 0.0027 inch thick there was moderate rusting at the end of about three months; a deposit 0.00686 inch thick did not show any rusting in 70 days, but it tarnished so badly that all resemblance to its original appearance was lost.

A brass deposit, 0.00023 inch thick showed slight rusting at the end of 20 days and was judged to be very badly corroded within 73 days; a deposit, 0.00327 inch thick was beginning to break down at the end of 53 days and rusting was very severe within 88 days; there was considerable tarnishing, but no rust developed within 70 days with a deposit 0.00607 inch thick.

Samples with a nickel plate, 0.00017 inch thick developed slight rusting at the end of 9 days and this was very bad after 40 days; a deposit, 0.00102 inch thick showed signs of breaking down in 19 days and was very badly corroded in 73 days; deposits, 0.00146 and 0.00249 inch thick were tarnished, but showed no rust in 122 days, while deposits 0.00598 and 0.00702 inch thick were bright and not even tarnished in 70 days.

In comparison with these the behavior of a zinc coating is noteworthy, inasmuch as a deposit less than 0.0002 inch protected the underlying iron completely, no rust being developed during four months exposure of very wet weather.

On the basis of these results one is forced to draw the conclusion, and this is confirmed by other evidence, that plated deposits of the usual

weight or thickness are porous; further, that a zinc coating is either less porous than any of the others or, what is undoubtedly the true explanation, that the zinc protects the iron by reason of its higher potential. This action was discussed at the beginning of this article. According to this view there are tiny holes or pores extending through a zinc coating, as well as that of any other metal, down to the iron, but the area of the iron surface thus exposed is so very much smaller than the surface of the zinc that the latter is able to protect the iron at its own expense; since copper, nickel, etc., do not possess this protective power, corrosion soon starts at these pores and spreads over the entire surface, more or less rapidly.

Porosity of Deposits Investigated

In connection with the porosity of plated deposits some interesting observations were made on this point and without going into too much detail, it may be worth while to describe briefly the procedure employed, for the sake of the plater or manufacturer who may wish to investigate his own finishes from this standpoint.

Use was made of a certain reagent, developed by other experimenters, which is very useful in work of this sort. It is prepared by making up a 1.5 per cent solution of agar in water; agar is a kind of seaweed and can be obtained at any large drug store or chemical house or, if desired, the gelatine which is used in bacteriological work may be employed instead of the agar. Both of these substances need to be heated gently and stirred for some time, to get them into solution; when a thin, clear jelly is obtained, 6 or 7 cubic centimeters of a 1 per cent solution of potassium ferrocyanide and a drop of strong sulphuric acid are added for each 100 cubic centimeters of liquid.

The plated part under test should be placed in a beaker or other vessel and the hot solution poured over it. The agar or gelatine soon hardens and sets; later small blue spots may appear and wherever they occur the presence of a hole in the coating is indicated.

The mechanism of the test is simple enough and depends on the formation of a blue compound, known as Turnbull's blue, when potassium ferrocyanide is brought into contact with a ferrous salt, that is, a certain type of iron salt. Whenever the iron is exposed by the presence of holes or pores in the plated coating it goes into solution as a ferrous salt and this then reacts with the potassium salt in the reagent to form the blue-colored compound.

It may be noted that this test can be used to determine the presence or absence of holes in paint, japan or lacquer films, as well as in plated deposits, but it may not be applied to zinc-plated parts, since the iron in such cases is always the cathode and would not dissolve, therefore, no color can be obtained.

Testing some of the other metal deposits, however, it was found by the investigator that copper films up to about 0.00034 inch thick showed pores or pinholes; nickel plate up 0.00102 inch likewise contained pinholes, but brass deposits of 0.00128 inch were free from them.

A test for the detection of porosity in zinc coatings consists in immersing the strips of zinc-covered iron in a strong and hot solution of caustic soda. Any spots of iron which are exposed become the cathode of a voltaic cell and hydrogen is evolved as a stream of fine bubbles. Thick and thin zinc deposits were tested in this manner and it was found that the thin ones were as full of holes as were the deposits of other metals.

How the Results Checked

As to how closely these results check with those obtained in actual weathering tests the author says:

"In weathering tests of two to four months duration, rusting occurred on brass and copper plate many times thicker than the minimum for the disappearance of pinholes. In case of the heavier deposits rusting was confined to spots a millimeter or less in diameter, the spaces between spots giving perfect protection to the iron beneath. For nickel plate there was good agreement between the disappearance of holes and freedom from rust. The divergence shown in this respect by copper and brass plating may possibly be due to the greater difference of potential between these metals and iron than that which exists between nickel and iron. The greater the difference of potential or corrosive force, the more difficult will it be to prevent rusting."

In any event, these tests should probably not be accepted too literally, in a quantitative way, if only for the reason that the character of a plated coating varies more or less according to the conditions under which it is deposited and it would not be entirely unreasonable to suppose that the porosity of the coating may vary likewise; nevertheless some idea regarding the continuity of deposits of different thickness, insofar as it is possible to determine this experimentally, can be obtained.

While on the subject of protective finishes, it may be interesting to note the results obtained by this investigator on a type of finish which has found favor among certain manufacturers and consists in plating iron parts with zinc and then covering this in turn with a plated deposit of some other metal, inasmuch as they confirm certain conclusions which a careful study of the case would enable us to draw from theoretical considerations.

Results of Double Coating

Disregarding the details, the test consisted in plating iron strips with zinc deposits ranging from 0.00013 to 0.00041 inch in thickness; on this there was plated copper ranging from 0.00062 to 0.00145 inch thick, while two strips were given a coating of brass, 0.00186 inch and 0.00327 inch thick, respectively.

Upon exposure to the weather all of the samples developed more or less rust in less than three months' time; some, indeed, showed signs of corrosion in two weeks. On the whole, it was found that the double coating gave only slightly better results than could be obtained by a copper or brass coating of equal thickness and it was shown that the effect of the copper or brass deposit over the zinc was to neutralize the protective effect of the latter so completely that little or nothing was gained by its presence.

The explanation of this is not obscure. It has been shown previously how zinc protects iron by being itself corroded, but inasmuch as the amount of iron exposed is vanishingly small when compared with the total area of the zinc surface, only very small quantities of zinc need to be dissolved in order to protect the iron completely at these points, while the rest of the zinc plays the part of an excluding coat in keeping air and water away from the iron. But zinc is electro-positive to copper also, therefore, when it is covered with a coating of copper, a small amount of it, at the places where there are pinholes in the copper, has a relatively enormous area of the latter metal to protect, since the tendency will be for the zinc to protect the copper at its own expense, as in the case of iron. The result is, of course, that the zinc is soon entirely dissolved away from the neighborhood of the holes in the copper and severe rusting soon follows, inasmuch as the copper, being electro-negative to iron, stimulates its corrosion.

Metallography Applied to Nonferrous Metals---I

This is the First of a Series of Elementary Articles Dealing With the Science That Embraces a Study of the Internal Structure of Metals and Alloys

By Ernest J Davis

METALLOGRAPHY embraces the study of the internal structure of metals and alloys. It is not a very old science, particularly as applied to nonferrous metals and alloys. Most of the early publications dealt with iron and steel, and the characteristic structure known as "Widmanstätten," first was discovered by Widmanstätten in 1808 by an examination of certain meteorites. This type of structure at one time was supposed to be found only in steel, but Fig. 1 which is a microphotograph of an alloy of copper, 88 per cent; aluminum, 10 per cent; iron, 1 per cent, and zinc, 1 per cent, exhibits a structure similar to that of Widmanstätten, and is now recognized in nonferrous alloys as well as steel.

Most of the early workers solely studied iron and steel and only within the last few years have the many nonferrous metals been investigated microscopically, particularly in the foundry. The mechanical properties of alloys depend to such an extent on their physical structure, that without a knowledge of their internal composition, full advantage of the mechanical properties cannot be gained. Many of the failures in making alloys are due to changes in the method of treatment or in other ways and these failures cannot be prevented until the causes which produce them are known, the microscope being our best ally to that knowledge. The chemist and chemical analysis tell us faults of composition, but as to how the various components are mixed, or whether the alloy contains foreign inclusions, size of crystals, or whether minute parasites exist, matters little to the chemist. These are problems for the metallographist to worry about.

The application of the microscope to the study of the structure of metals and alloys has developed rapidly within the last few years. Accurate methods of examination are known and a vast amount of data has been gathered, in fact practical metallography has now come to be regarded as a valuable asset to a works laboratory.

For the microscopic examination of metals and alloys, three factors must be considered: (1) The preparation of the sample; (2) the magnifying instrument—the microscope—with which the examination is conducted, and (3) the methods of making the examination.

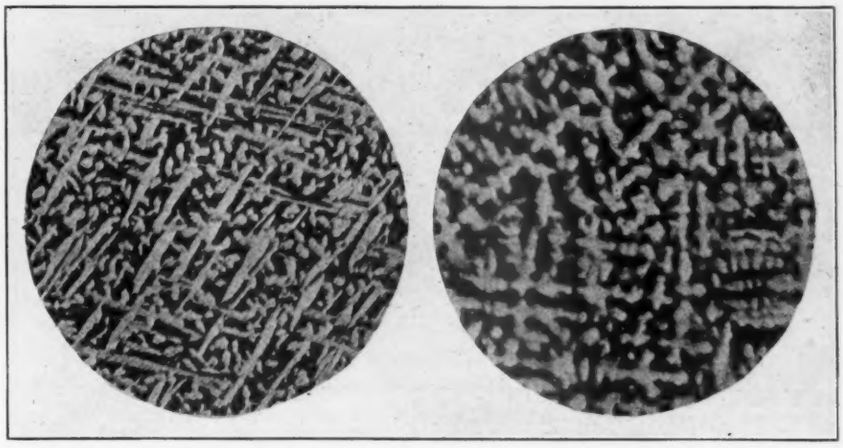


FIG. 1—WIDMANSTATTEN STRUCTURE OF A COPPER-ALUMINUM-IRON ZINC ALLOY
(MAGNIFICATION, 100 DIAMETERS)

FIG. 2—DENDRITIC STRUCTURE OF COPPER-NICKEL ALLOY
(MAGNIFICATION, 100 DIAMETERS)

The preparation of a specimen of metal for microscopic examination necessarily begins with the choice of the surface to be examined. Here the personal knowledge of the worker comes into play to a very large extent, for the choice of the section must depend in every case upon the particular object to be attained, and upon the conditions of the case. Thus, where an investigator is studying the structure of a series of alloys with regard to their possible constitution, he will generally examine the entire vertical cross-section of his ingots to detect any lack of uniformity of composition. It is not practicable to examine the whole of every ingot and in the case of large ingots a number of small sections are cut out and examined. More complex conditions affect the choice of specimen in worked samples as the influence of mechanical treatment always produces difference of structure according to the direction in which the section is cut relative to that in which the work has been applied. In the case of controlling the foundry melting operations a section may be cut out at any suitable position of the sample bar.

Having decided where to take the section, a piece about $\frac{3}{8} \times \frac{3}{8} \times \frac{1}{4}$ inch is cut out by means of an ordinary hack-saw or a piece, in the case of very hard alloys, may be broken off by a blow from a hammer. An oxyacetylene blow-pipe should not be used, as the temperature obtained by the metal, even at some distance from the line of the blow-pipe, is high enough to appreciably alter the structure, and possibly efface the very features which are being sought. After cutting-out, a flat surface is prepared by rubbing it on a dead-smooth file. Grinding-wheels may be used, those of the slow revolution type being preferable, as the heating of the surface of the sample when using fast revolving wheels is apt to cause faulty structures to be produced. If fast, wheels are employed, the specimen may be kept cold by dipping in water occasionally, but the continuous taking and replacing the specimen on the wheel is apt to give a slightly curved surface which is troublesome in the later stages of the examination.

The next operation is to polish the flat surface. This is done by rubbing on emery papers of increasing fineness. The writer uses papers pasted on pieces of plate glass starting with No. 1, 0.00, and 000, and finally finishing on a revolving disc on which is stretched fine wash leather or emery cloth, fed with a powder known by the trade name of "Diamantine." In passing from one emery paper to the next finest, it is advisable to reverse the direction of rubbing through a right angle; one is thus able to see when the scratches

from the previous paper are removed, thus saving considerable time. The polishing of a micro-specimen requires considerable care and skill and one can only insure success after having had considerable experience and by being scrupulously clean.

The specimen is now ready for the development of the structure which is done by etching. The foregoing procedure, of course, is modified according to the metal on which the work is being done. For instance, aluminum requires extreme care and it is sometimes better to use a little light oil, such as paraffin, on the emery papers when polishing.

The structure may be developed in a number of ways, but for our purpose the most useful is known as *etching*. The polished specimen is immersed in some reagent which attacks different constituents at different rates, thereby giving a means of identification under the microscope. Various reagents are employed for this purpose, but for non-ferrous metals diluted ammonia is a good all-round reagent. Just a drop of the ammonia is carefully rubbed on the polished specimen with the finger until the required depth of etching is obtained; it then is washed under the tap and quickly dried, when the section is ready for examination.

A 10 per cent solution of ammonium persulphate is also a good reagent, especially for alloys of copper and zinc. Acid ferric chloride is useful for the copper-tin alloys. This reagent also may be used for manganese bronzes, certain aluminum alloys such as aluminum-nickel, alloys rich in antimony, bismuth or tin. For white bearing metals and babbitts, 10 per cent HCl is useful, but I have obtained good results with 1 per cent HNO_3 in alcohol for these alloys. For alloys rich in zinc or aluminum 5 to 10 per cent caustic soda is generally employed.

After etching, the specimen is ready for microscopic examination. Any good metallurgical microscope is suitable for the work, but it is desirable that it should be fitted with an inclining joint so that it may be used in both horizontal and vertical postions. It should have also a rough and fine adjustment. Metallurgical microscopes are fitted with a movable stage upon which the specimen under observation may be moved backward and forward by mill-headed screws which enable one to examine the whole surface of the specimen. Metallic specimens, being opaque masses, cannot be examined by transmitted light; consequently, special illuminating apparatus has to be used. For the examination of metals and alloys vertical illumination usually is employed. It is produced by having a hole in the tube of the microscope just above the objective. A small, right-angle prism is placed in such a position that it reflects any light which passes on to it through the hole, down on to the specimen and is then reflected from the surface of the specimen up the tube of the microscope past the prism to the eye-piece. Any good light will do for the illumination, but for photography a small arc-lamp is preferable. The structure of metals and alloys, as seen under the microscope, may be divided into four distinct general types such as that of (1) pure metals; (2) chemical compounds; (3) solid solutions, and (4) eutectics.

When a pure metal solidifies from fusion it is obvious that the resultant solid must be chemically homogeneous; it must have the same composition throughout, and any lack of homogeneity can only be due to the formation of holes by contraction during solidification, or perhaps from dissolved gases, if the term *pure metal* be not held to exclude metals holding gas in solution. As the metal solidifies crystalization takes place and the form and size of the crystals depend on the metal and on the rate of solidification. Frequently crystals grow inwardly from the cooling surfaces into the still molten interior, the main branches throwing out arms and the liquid mass subsequentlly freezing between them, these forming a large feathery pattern commonly known as *dendritic*, Fig. 2. More frequently crystalization commences from a number of centers, the crystals growing in all directions into the molten interior or mother liquor, the spaces between them becoming gradually filled and finally pressing against one another, the regular crystalline form is destroyed and an irregular polygonal structure results, Fig. 3. A microphotograph of pure copper magnified 100 times is typical of this. As will be seen by reference to Fig. 3, there is a mass of roughly polygonal areas separated from one another by narrow dark lines. These polygonal areas are readily recognized as representing sectional views of a number of roughly polygonal grains which constitute the entire mass of metal. The nature of these grains are now known and they are recognized as true crystals. It is true that these crystals lack one of the most striking features of most crystals, namely, geometrical outline, but this is explained by the fact that none of these crystals has had the opportunity for free growth, which is requisite for the development of geometric form, the growth of individuals being stopped by their neighbors.

The essence of crystalline form does not reside in geometric outline or shape, but in the regular arrangement of the

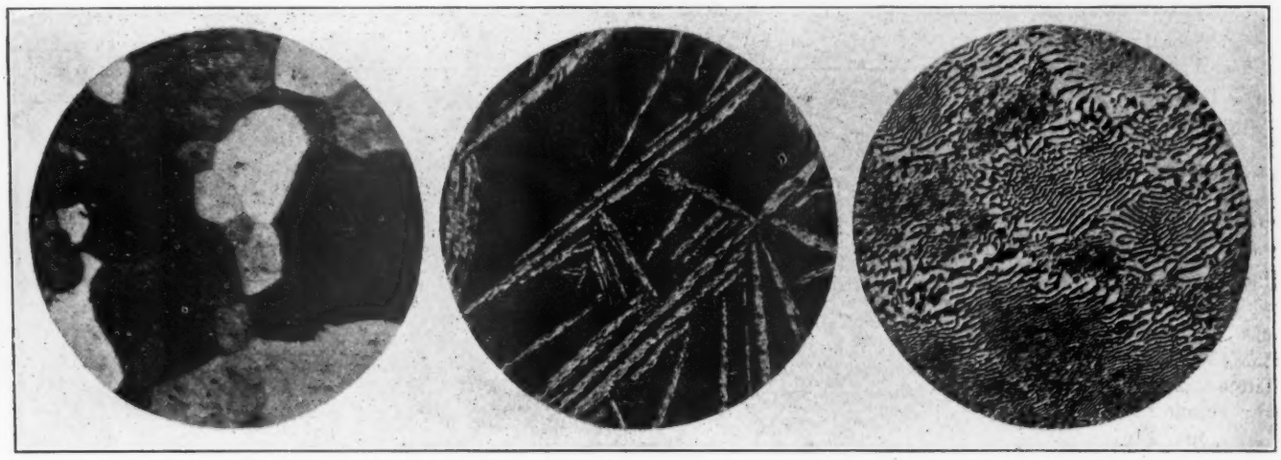


FIG. 3—POLYGONAL STRUCTURE OF PURE COPPER
(MAGNIFICATION, 100 DIAMETERS)

FIG. 4—STRUCTURE OF A 5 PER CENT PHOSPHOR-TIN ALLOY
(MAGNIFICATION, 100 DIAMETERS)

FIG. 5—STRUCTURE OF LEAD-TIN EUTECTIC CONTAINING 27 PER CENT LEAD
(MAGNIFICATION, 100 DIAMETERS)

molecules within the mass, geometric outline being merely one result, which is apparent only in favorable circumstances. It will be noted that some of the crystals in Fig. 3 appear dark and others light. This is due to an optical effect, which can readily be proved by examining the same field under oblique illumination, when we get the reversed effect; those that appeared dark then appear light. In fact, by rotation of the specimen on the stage of the microscope, one can see the dark crystals gradually becoming light and the light ones gradually becoming dark. To understand the nature of this phenomenon we must consider for a moment the manner in which the surface of the specimen has been prepared. The important point is the etching process, since before etching the surface was a uniform plane. Now the action of an etching reagent, is that of a weak salient and it effects solution by gradually dismantling the structure of the metal exposed to its action; if the different crystals which have been sectioned by the polished surface are each built up on a separate system, each will be dismantled by the etching fluid according to that system. This process actually exposes a number of minute facets, differing in size and position, but all of the same shape and similarly oriented, that is, all facing one way over the entire part of the surface belonging to one crystal, but as a rule —differing from crystal to crystal.

Character of Etched Surface

Furthermore, it is found that this dismantling of the crystals by the process of gradual solution does not proceed at the same rate upon all the crystals exposed in the section—in fact the rate of attack differs slightly from crystal to crystal according to the different orientation of the molecules or groups of molecules of which the crystals are built up. An etched surface, therefore, consists of a series of polygonal areas corresponding to the various crystals intersected by the surface, each at a slightly different level and thus necessarily connected by short, steeply sloping surfaces, and each covered with a system of minute facets which are the same for individual crystals, but vary from crystal to crystal.

Under vertical illumination, the light striking the steeply sloping surfaces is reflected away from the microscope and they thus appear as fine, dark lines. The minute facets are too small to be seen except under very high magnification, but the various systems of facets may be so arranged that some totally reflect the light away from the microscope and thus appear dark, while others are arranged so as to reflect all the light to the eye-piece of the microscope and thus appear light. On rotating the specimen those systems which appeared dark become favorably placed and become light, while the areas which appeared light gradually wane and finally become dark. If the etching process is carried far enough, the actual facets can be seen and the mode of crystalization of some of the metals has thus been demonstrated.

Chemical Compounds

The next constituent—necessarily confined to alloys—is the chemical compound. None of these compounds is of much importance with the exception of those that occur in bearing alloys and, as a rule, intermetallic compounds are hard and brittle and impart the same property to the alloys containing them. Fig. 4 shows the microstructure of a 5 per cent phosphor-tin alloy; the white bars are a hard compound of phosphorus and tin. On solidification, these compounds behave exactly like a pure metal; in fact we cannot tell by the microscope whether our sample is a pure metal or wholly a chemical compound.

The term *solid solution* is given to a homogeneous mixture of two or more substances in the solid state. Its structure is exactly similar to a pure metal as the definition applies.

The term *eutectic* means *easily melted* and is used to name that combination of two or more substances which has a lower melting point than any other proportion of the same constituents. Eutectic alloys, according to Dr. Stead, have usually one of three structures: Curved plates, flat plates and honey-combed or cellular. Fig. 5 is a typical eutectic structure of the curved plate type.

Alloys in Commercial Use

Most alloys are more complex in structure and contain two or more of the foregoing constituents; a solid solution separates, and then the mother liquor solidifies forming the eutectic, or there may be more than one stage of solidification before the eutectic point is reached.

The number of alloys in commercial use is very large and for our purpose may be divided into the following four groups:

1.—Copper alloys (Brass, bronze, etc.)
2.—Aluminum alloys.
3.—Bearing alloys (Tin, antimony and lead alloys.)
4.—Nickel alloys (Nickel, silver, etc.)

In this series of articles it is proposed to discuss each group of alloys and to illustrate their microstructures: also, to show how the microscope can be utilized to control the manufacture of such alloys to the best advantage.

Zirconia as a Refractory Material

Metallurgical possibilities of zirconia were discussed at a recent meeting of the Birmingham, England, Metallurgical society, in a paper by Leopold Bradford. Zirconia in its purest condition, has probably the highest melting point of any metallic oxide known. This material was first isolated by Klaproth in 1789 from the mineral zircon. He also discovered its presence six years later in Ceylon. Both these minerals are silicates of zirconium.

Zirconia-bearing minerals are quite widely distributed, being found in Ceylon, North and South America, the Ural mountains, Norway and Australia, and in a lesser degree, in the monazite sands of India.

Zirconia has several features in common with silica and alumina, but a study of the salts which it forms with potassium and fluorine shows that it is more closely allied to titania. It is a white powder when pure, sometimes with a smooth, oily touch according to the manner of preparation.

It is a nonconductor of electricity, unless heated to a high temperature. Strongly ignited zirconia is stable to acids and alkalis. Though pure zirconia alone, when molded for the production of refractory articles such as crucibles, is apt to crack and crumble, even when heated gradually, these drawbacks can be overcome by fusing the oxide. This can be carried out in a modified type of arc furnace at 50 amperes, 220 volts. Afterward the fused mass is ground in a steel ball mill. The powder thus obtained is then molded or pressed into the required shape with or without bonding material.

After gradually drying, the articles are burned at 2300 to 2400 degrees Cent., until contraction ceases, in a cylindrical oven constructed chiefly of fused zirconia. The fuel used can be either gas, oil or acetylene supplied with a blast of air and finally one of oxygen.

Crucibles thus made should give a clear ring when sharply tapped and they are as fine in texture as porcelain. The shrinkage of the articles varies with the size of the particles of zirconia. If a finely ground material is used, the total shrinkage is approximately 20 per cent.

Fused zirconia resembles fused quartz in some respects, but when it is cooled rapidly it forms an opaque mass of minute crystals and not a clear glass. It has a high thermal endurance and is not affected when heated to redness and plunged in cold water as its coefficient of expansion is 0.00000084 which is near that of quartz glass.

Zirconia's resistance to crushing stress is greater than that of quartz glass. Fused zirconia is a valuable refractory.

PROBLEMS OF THE BRASS FOUNDER

What To Do and How To Do It

Steel Inserts Cause Blowing of Aluminum Castings

We are making a number of large aluminum castings that have steel inserts. The difficulty we are experiencing is due to these inserts blowing, although they are copper coated. The castings are filled with blow-holes around the inserts.

Moisture is the cause of the steel inserts blowing. The steel is cooler than the sand of which the mold is composed and therefore the vapor which continually arises from the damp sand is condensed on the surface of the inserts. When the molten metal comes into contact with the water, the latter is converted to steam, forming bubbles which remain in the vicinity of their source, and by keeping the aluminum from filling the space they occupy, they form voids.

If the inserts are warmer than the sand, the moisture cannot condense thereon as it is driven off by the heat, so the thing to do is to have the inserts warm before pouring the molds. The most practical manner in which to accomplish this is to leave off the copes until just before pouring, then to go over the inserts with a gasoline torch and heat them; then close the molds quickly and pour. To prevent the mold being burnt around the inserts, use a facing at these points made of dry molding sand wet with a 15 per cent solution of silicate of soda in water. The copper coating on the steel will not prevent it blowing, because it fails to prevent the condensation of moisture.

Manganese Bronze Subjected to Superheated Steam

We would like to obtain a mixture for manganese bronze that will withstand superheated steam pressures. We are making valves which are tested at 800 pounds water pressure, but which leak at 750 pounds. The valves weigh from 35 to 60 pounds each. We are using the following composition: Copper, 56 pounds; zinc, 38½ pounds; manganese, 5 pounds and aluminum, ½ pound. The castings are full of dross when poured and some cracked when tested.

It would be advisable to use the following alloy: Copper, 60.75 per cent; 30 per cent, manganese-copper, 2 per cent; tin plate clippings, 0.5 per cent; tin, 0.5 per cent; aluminum, 0.25 per cent and zinc, 36 per cent. Melt the copper with a small handful of salt and some charcoal, and when thoroughly liquid, add the tin plate loosely coiled; stir, add the aluminum and be sure that the tin plate is melted, then add the manganese-copper, followed by the zinc in small pieces; stir strongly and add the tin, pull the pot and ingot the alloy. For the castings, remelt the ingots.

If the castings still leak, try to run them without the aluminum, but add 1.25 per cent of silicon-copper in place of this metal and 1 per cent of the regular copper in the charge. Put heavy risers on thick parts of the castings and exercise your ingenuity in gating so that the metal instead of dashing into the mold, will rise gently from the lowest point and will finally flow up into the riser.

Casting Copper Auto Iron Pipe

We would like to know, in casting iron pipe in copper, whether it is more advisable to use pipe that has been galvanized or pipe originally black, but which has been sand-papered, filed and cleaned. Galvanized pipe, we know can be soldered, but we would like your views regarding the effect of casting copper over it. The castings weight from 4 to 1500 pounds each, and must contain 98 per cent copper.

We do not advise the use of galvanized pipe in making these castings, as the zinc is burnt off the pipe, creating a disturbance of the metal that might break parts of the mold; also, oxide would be formed, which would condense in the upper parts of the mold and produce dirty castings. Use clean iron pipe and heat it before pouring the mold. This can be done before laying the pipe in the mold, or after, as convenient, but the feature to be careful about is not to cause the pipe to oxidize and form a scale; otherwise the casting will blow. It will be necessary to so make the prints in which the pipe is held, that they will not burn and disintegrate by exposure to the heat of the pipe. It should be well secured and protected against perforation by the metal if the latter strike it when filling the mold. A copper casting of 98 per cent purity should be made without difficulty by observing these precautions.

Casting Copper Tapping Jackets

Recently we experienced considerable trouble in producing copper castings for matte tapping jackets. To provide for water-cooling a ¾-inch pipe is cast-in and the center hole is made with a chill. The copper is melted in a coke-fired furnace using a No. 60 crucible, as 160 pounds of metal are required to pour this casting. While melting, the copper is kept under a cover of charcoal and when ready to pour is clean and fluid. However, after the copper has been in the mold about 10 seconds, it begins to rise and overflow from the pouring head, producing castings full of holes. The pipe used for water cooling was heated to redness before being inserted in the mold.

Your difficulty is due to your failure to use some deoxidizer in the copper to make it run solid. The fact that the copper appeared clean and fluid before pouring indicates that it was properly melted and would have produced sound castings if it had been properly treated before being poured into the mold. The addition of 1 per cent of 10 per cent silicon copper would have produced sound castings. The pipe that is cast in this part should be sand-blasted and heated before it is placed in the mold, but it should not be heated to a temperature that will cause blisters to form, as otherwise it will cause the metal to flow. The surface of the casting that must be free from defects should be cast in the drag, the gates entering at the lowest point and the castings must be fed by the use of heavy risers which should be filled continuously with fluid metal while the mold is being poured.

Core Mixture for Nonferrous Castings

We would like to obtain a number of core mixtures for brass, bronze and aluminum castings, suitable for both large and small castings.

The following sand mixture makes good cores for brass castings: New molding sand, 5 pounds; lake or other sharp sand, 7 pounds, and an oil binder 6 ounces. Mix the lake and molding sands thoroughly with the oil and add sufficient water to bring to the proper degree of dampness. For a rosin sand core, mix lake or other sharp sand in

the proportion of 30 pounds; molding sand, 10 pounds and powdered rosin 2 pounds. Wet the mixed sand and rosin with water, and after the cores are made, spray with water and bake in an oven hot enough to thoroughly melt the rosin. Handle the cores carefully while hot.

The rosin sand mixture is better for round cores that are baked without dryers, as it is strong when green permitting the cores to be transferred from the core box to the plate on which they are dried with a minimum of breakage. The strength of the core, when it is green, depends upon the amount of molding sand that is mixed with the sand; therefore, the mixtures given are merely suggestive, as the proportions of molding sand and sharp sand must be varied to suit the work in hand. Cores that are made in halves and afterward pasted together, are not handled when green, and it is often expedient to make them entirely of sharp sand, because the vents come off more easily. The oil sand mixture makes the strongest cores and has the advantage of not softening when stored.

Increasing Elongation of Manganese Bronze

We would like to know how to increase the elongation of manganese bronze. We are using manganese bronze ingot, 200 pounds; zinc, 5 pounds, and the remainder scrap castings, carefully melted in a coke-fired furnace. We have added manganese-copper, but it seems to increase the tensile strength and lower the elongation. The gates can be broken off the castings easily. We would like to use one-half ingot and one-half rejected castings in our mixture. Also let us know what you think of the form of the test bar submitted.

There is a possibility that the elongation of the metal may be increased by holding it in the furnace and vaporizing a portion of the zinc. To accomplish this, melt the manganese bronze to the flaring point, then check the furnace, and time the metal. Allow it to flare 15 minutes, then cool with excess metal, remove from the furnace and pour into the molds. Manganese bronze is a difficult alloy to make. It is impossible to tell whether the ingot and scrap castings you proposed to use are suitable for the work, unless the composition is known, as it is possible that the metal may be radically different from that required. The test bar submitted is not suitable for manganese bronze, as it will give low physical properties. The bars should be made in the manner outlined in full in the July, 1917, issue of THE FOUNDRY.

Welding Bronze Castings

We would like to obtain some information regarding the welding of bronze castings of the following composition: Copper, 88 per cent; tin, 10 per cent and zinc, 2 per cent. These are to be subjected to steam pressures ranging from 50 to 275 pounds. Can these castings be welded satisfactorily? As a guide the following particulars are presented. The thickness of wall section varies from 9/16 to 3 inches. Is preheating necessary? If preheating is necessary, to what degree? What would be the proper color? Should the preheating be done in a closed or a semi-closed space, thus retaining heat and reducing the time required to bring the casting to the proper temperature? May a gasoline blow torch be used to preheat the casting? If carefully preheated is it necessary to cover the casting with anything other than sheet asbestos to prevent too rapid cooling? What precautions are necessary to avoid cracking due to uneven heating? The principal defects are cracks, blow-holes, and spongy sections in bodies and flanges near and under risers, and in abrupt changes of section.

Castings of the composition given can be welded. We doubt, however, if the areas to be covered are extensive, whether a satisfactory job can be done, either by burning or welding. Preheating is necessary and the hotter the casting can be made the better it will be so far as the welding is concerned. There are limiting factors to the degree of heat that can be applied. Some of these are obvious, such as the method of application. The greatest limitation, however, is that imposed by the strength of the metal at high temperatures. At a bright red heat the castings would fall apart of their own weight at points where sections are allowed to hang. They would have to be filled with sand internally and encased in a mold to be safe. In this case it would be difficult to heat them to the desired temperature. It is evident that the castings cannot be heated to a bright red without extraordinary difficulty, and it would be easier to make new castings and scrap those made.

It is probable that the temperature to which the castings can be preheated will be considerably below dull redness. Owing to the high heat conductivity of the bronze, unless the castings are well insulated, a point would be reached where the heat lost by radiation would balance the applied heat. If the castings are small, they should be heated in a muffle placed near the operator, from which they could be removed quickly and welded. A gasoline torch would be useless for any but small castings, and for these the muffle is best.

For this particular alloy, the castings should be cooled slowly and away from drafts; if they are enclosed, and the enclosure covered with sheet asbestos, this will be satisfactory. To avoid cracking, uneven heating must be avoided. A good way to preheat large castings is to place them on a truck and after they have been carefully supported so that all strain is removed from overhanging parts, they should be placed in an oven where they can be heated uniformly. After removing the castings from the oven, proceed with the welding operation as long as possible. When the castings begin to cool, run them back into the oven; after welding has been finished, let them cool on the truck before removing them.

Poor foundry work is responsible for the defects mentioned, and before attempting welding on an extensive scale, it would be advisable to discover what is the matter with the manager of a foundry that permits such castings to leave the shop.

Alumina Inclusions in Aluminum Castings

Minute holes in the aluminum castings which we are making are causing heavy rejections and we would like to know how this difficulty may be overcome.

We believe, from an examination of the aluminum casting submitted, that these minute holes are caused by alumina inclusions since the outlines are irregular; on the other hand, sand holes made by sand inclusions are more regular in outline. The small holes on the outer skin of the castings are caused by grains of sharp sand, either from the core or the parting, if sand is used for the joint. The holes that cause the trouble, however, appear to be concealed until the casting is machined, when they are exposed.

Aluminum oxidizes every time it is melted and, therefore, reclaimed aluminum will contain more alumina than new ingot aluminum. The alumina does not rise to the surface of the melted aluminum readily as the metal is rather viscid and because of the greater specific gravity of the oxide it does not rise to the surface. We suggest that some means of agitating the aluminum be tried while it is in the furnace with a view of expelling the suspended alumina. Stirring thoroughly with a stick might cause the particles of the alumina to rise to the surface and this should be followed by the addition of a small amount of chloride of zinc.

Double Pass Recuperative Furnaces Save Fuel

European Types of Recuperative Furnaces Which Differ from Usual Types Are Operated Successfully at High Temperatures

REGENERATIVE furnaces have been the means of effecting immense savings of fuel in steel works practice. Since the introduction of these preheaters, few improvements have been made in their construction other than a few minor changes in the reversing valves, checker work, size of chambers, etc. That the recuperative furnace so far has not displaced the regenerative system, is due to the inability of the former type to withstand temperature between 1300 to 1500 degrees Fahr. for any length of time without undergoing repair. Since repairs to the heating system necessitate shutting down the furnace and in many instances the rebuilding of the furnace, it is further understood why the recuperative system met with disfavor heretofore among the steel makers in this country.

However, in Europe several recuperative furnaces are in successful operation and are worth investigating because they are built differently than the usual type of reheating furnaces. The recuperative furnaces previously mentioned are constructed of hollow brick blocks which are built with a male flange on one end and a female flange on the other as shown in Fig. 1. The walls of the bricks are 1⅛ inches thick. When

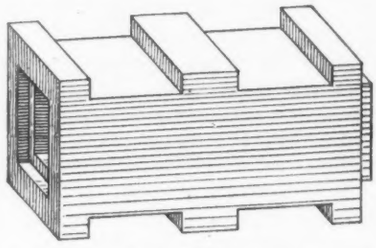


FIG. 1—SHAPE OF FIRE BRICK USED FOR RECUPERATOR FLUES

several rows of blocks are placed adjacent, they form flues through which the products of combustion pass. Other courses are mounted on top of and parallel to the first row of blocks. Transverse flues are formed between the upper and lower surfaces of these blocks and it is through these flues that the secondary air is heated before mixing with gas.

The heating furnace shown in Fig. 2 is constructed on top of the recuperator. The gas enters the lower combustion chamber of the recuperator and flows to the rear where it commingles with preheated secondary air. Ignition takes place, the products of combustion passing down a vertical flue which connects with three horizontal channels. The gas passes through these channels to a vertical flue, and then returns through three lower rows of horizontal channels to a vertical flue. This flue directs the gas to the opposite side of the furnace where it passes zigzag through channels arranged similarly to those just described. The gas leaves the channels at the top of the furnace and is discharged into the air.

The secondary air is heated by passing through the ducts that are formed by the collars on the channel blocks when placed one upon the other. The air enters these ducts at that section of the furnace where the combustion gases are exhausted into the atmosphere. The air passes in a zigzag manner through these ducts until it reaches the bottom course where it is transferred to the opposite side. The temperature of the air is further increased by passing through another series of ducts which discharge into a central chamber. From this chamber the air is directed to the combustion chamber and mixes with the incoming gas.

Recuperator furnaces, similar to the one previously described are used successfully at many iron and steel plants. When used in connection with puddle furnaces, the air for combustion passes into a chamber midway between the dome of the furnace and gas chamber.

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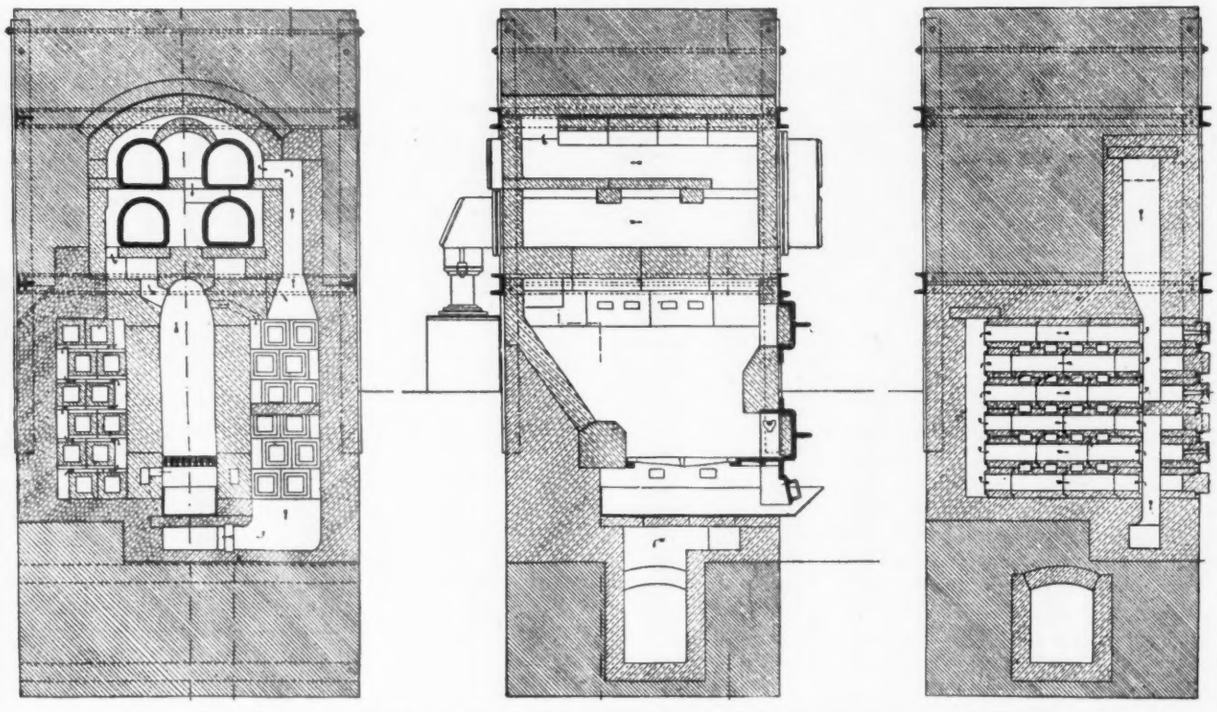

FIG. 2—FRONT, SIDE AND SECTIONAL VIEW OF RECUPERATOR FURNACE—ARROWS INDICATE THE COURSE TRAVELED BY THE GASES

Milwaukee Prepares for Great Metals Meeting

Simultaneous Gatherings of Four Leading Metal Trades Organizations Will Attract the Country's Most Important Manufacturers—The Exhibition Will Be a Record-Breaker

DURING the week of Oct. 7, Milwaukee will be the center of attraction of the metal-working industry of this country. The simultaneous meetings of the American Foundrymen's association, iron and steel section of the American Institute of Mining Engineers, Institute of Metals Division of the American Institute of Mining Engineers and the American Malleable Castings association, combined with the government exhibition of all kinds of labor-saving, metal-working equipment, will assume the proportion of a great allied metals congress.

Every branch of the metal industry will be represented, including the gray iron, steel, malleable iron and brass foundry trade; iron and steel industry from the mining of the ore to the production of pig iron, its conversion into steel and finally the rolled product and the brass and copper rolling mill industry. The keynote of many of the addresses and papers that will be presented will be the acceleration of production for the prosecution and winning of the war. In fact, the purpose underlying the holding of this allied metals congress is to afford manufacturers of ordnance and other war equipment an opportunity for an interchange of ideas regarding methods of production and to ascertain, if possible, how their practice may be improved.

The great interest that is being manifested in this event is reflected by the large number of reservations for space in the Milwaukee auditorium, where the exhibition will be held. Already 165 manufacturers have closed contracts for representation in the arena and machinery hall and only a comparatively small amount of space is still available. Indications point to the largest show of this kind ever held in this country.

The manufacturers of Milwaukee have organized to provide for the entertainment and reception of the visitors. The program, although not definitely outlined, will include a reception and dance at the Milwaukee auditorium, theater party and in addition the ladies will be taken on an automobile sightseeing tour and will be tendered several luncheons. Plant visitation probably will be confined to Thursday and Friday and many of the notable plants in the Milwaukee district have signified their willingness to permit the inspection of their works at this time. On Thursday evening, Oct. 10, the banquet will be held and addresses will be delivered by speakers of international fame.

The following committees on arrangements have been appointed for the reception and entertainment of the visitors:

General Committee

Theo. O. Vilter, chairman, president, Vilter Mfg. Co.; W. J. Fairbairn, secretary, Milwaukee Metal Trades and Founders' association; A. E. Harrison, superintendent foundry and pattern shop, Allis-Chalmers Mfg. Co.; E. W. Bearman, Illinois Steel Co.; John D. Bird, general manager, Power & Mining Machinery Co., Cudahy, Wis.; James L. Marshall, general manager, Geo. H. Smith Steel Castings Co.; W. G. Bruce, secretary, Milwaukee Association of Commerce; Henry Weber, chairman, Milwaukee park board; Geo. Kuemmerlein, superintendent of transportation, Milwaukee Electric Railway & Light Co.; A. E. Copeland, manager, Hotel Wisconsin; W. P. O'Connor, general agent, Goodrich Transportation Co.; F. C. Reynolds, general agent, Pere Marquette railroad, and Jos. C. Grieb, manager, Milwaukee auditorium.

Finance Committee

Theo. O. Vilter, chairman, Vilter Mfg. Co.; W. G. Bruce, Milwaukee Association of Commerce; C. R. Messinger, Chain Belt Co.; J. D. Bird, Power & Mining Machinery Co., Cudahy, Wis.; T. A. Glasscott, Pickands, Brown & Co.; John Thomas, Thomas Furnace Co.; A. J. Lindeman, Lindeman & Hoverson Co.; Otto H. Falk, Allis-Chalmers Mfg. Co. and Walter Kasten, treasurer, finance committee, Wisconsin National Bank.

Entertainment Committee

Geo. Kuemmerlein, chairman, Milwaukee Electric Railway & Light Co.; Henry Weber, Milwaukee park board; J. J. McDevitt, S. Obermayer Co.; John Mertes, Federal Foundry Supply Co.; E. B. Lemon, chemist; T. A. Glasscott, Pickands, Brown & Co.; James L. Marshall, Geo. H. Smith Steel Castings Co.; F. C. Reynolds, Pere Marquette railroad and J. S. Pinson, Avery Co.

Golf Committee

J. D. Bird, chairman, Power & Mining Machinery Co., Cudahy, Wis.; C. R. Messinger, Chain Belt Co.; David McLain, McLain's System; F. E. Layman, chemist and C. G. Ocock, Avery Co.

Plant Visitation Committee

A. E. Harrison, chairman, Allis-Chalmers Mfg. Co.; James L. Marshall, Geo. H. Smith Steel Casting Co.; H. R. Donald, Essley Machinery Co.; Wells K. Gregg and H. G. Siefert.

Reception Committee

E. W. Bearman, chairman, Illinois Steel Co.; Frank Cleveland, Milwaukee Association of Commerce; David McLain, McLain's System; J. D. Shaw, Shaw Foundry Co.; E. A. Wurster, Falk Co.; J. J. McDevitt, S. Obermayer Co.; Henry R. Donald, Essley Machinery Co.; T. A. Glasscott, Pickands, Brown & Co.; O. B. Pupikofer, American Gum Products Co.; W. J. Fairbairn, Milwaukee Metal Trades & Founders' association; Roy Smith, Hotel Pfister; A. E. Copeland, Hotel Wisconsin; Henry W. Wehr, Wehr Steel Castings Co.; Herman Kletzsch, Republican House; W. W. Sommes, Hotel Carlton; W. M. Nefzger, Hotel Schlitz; S. Duffy, Hotel Plankinton and F. B. Sweeney, Hotel Maryland.

Banquet Committee

W. P. O'Connor, chairman, Goodrich Transportation Co.; A. E. Copeland, Hotel Wisconsin and H. Weber, Milwaukee park board.

Theater, Automobile and Boat Excursion Committee

James L. Marshall, chairman, Geo. H. Smith Steel Casting Co. and J. J. McDevitt, S. Obermayer Co.

Ladies Committee

A. E. Copeland, chairman, Hotel Wisconsin; F. C. Reynolds, Pere Marquette railroad; Henry Weber, Milwaukee park board and O. B. Pupikofer, American Gum Products Co.

The meetings of these organizations will be opened on Tuesday morning with a joint session, at which the address of welcome will be delivered by Emmanuel L. Phillip, governor of Wisconsin. This will be followed by addresses relating to the importance of the metal-working industry in the prosecution of the war, to be delivered by speakers of note who are familiar with the activities at Washington. Upon adjournment, the opening sessions of the American Foundrymen's association, Iron and Steel Section and Institute of Metals Division of the American Institute of Mining Engineers will be called to order in separate halls in the Milwaukee auditorium, where the activities of the allied metals congress will be centered. The exhibition will be formally opened on Monday afternoon, Oct. 7. Beginning Tuesday, Oct. 8, the American Foundrymen's association will hold daily meetings, confined to the morning only, and on several days simultaneous sessions will be necessary to dispose of the lengthy program by Friday noon, Oct. 11. The Institute of Metals Division of the American Institute of Mining Engineers will have one meeting on Tuesday, two on Wednesday and one on Thursday. The Iron and Steel Section of the American Institute of Mining Engineers will hold three meetings and will adjourn Wednesday afternoon. Only one meeting is scheduled by the American Malleable Castings association.

One of the notable features of these meetings will be the large number of interesting moving pictures that will be shown. These will include the use and manufacture of hand grenades; the civil re-establishment of wounded and crippled Canadian soldiers; the manufacture and

launching of ships at the Hog Island yard, Philadelphia; the building of concrete ships; the manufacture of steel by the triplex process, and the cause and prevention of industrial accidents.

The program of the American Foundrymen's association includes a large number of papers of interest to manufacturers of gray iron, steel and malleable castings. To dispose of the program in the time allotted, separate sessions will be held for the consideration of papers relating to gray iron, steel and malleable iron foundry practice. An accident prevention conference also is scheduled at which a large number of papers will be presented and addresses delivered on the conservation of life and limb in industrial plants. A tentative program of the topics that will be discussed follows:

"Sand-Blasting Equipment," by C. T. Bird, Pangborn Corp., Hagerstown, Md.

"Engineers—Their Relation to the Foundry in the Saving of Labor," by E. S. Carman, Cleveland Osborn Mfg. Co., Cleveland.

"Pouring Devices," by Mark P. Ohlsen, Brillion Iron Works, Brillion, Wis.

"Effective Means of Improving the Quality of Sand Mixtures," by H. B. Hanley, New London Ship & Engine Co., Groton, Conn.

"Common Troubles in Cupola Practice Which Tend to Cut Down Production," by G. S. Fisher, Whiting Foundry Equipment Co., Harvey, Ill.

"Women in Foundries," by C. E. Knoeppel, C. E. Knoeppel & Co., New York.

"Organizing a Foundry for Tractor Production," by Paul M. Ramp, Moline, Ill.

"Coke Problems of the Foundryman," by J. A. Galligan, Pickands, Brown & Co., Chicago.

"Recent Developments in Burning Oil in Cupolas," by John Howe Hall, Taylor-Wharton Iron & Steel Co., High Bridge, N. J.

"Continuous Operation of a Two-Story Foundry," by J. F. Ervin, Michigan Motor Castings Co., Flint, Mich.

"Sale and Distribution of Foundry Pig Iron in War Times," by C. J. Stark, editor, *The Iron Trade Review*, Cleveland.

"Concrete Foundry Floors," by George Moyer, Textile Machine Works, Reading, Pa.

"Training Your Own Help Instead of Competing with Other Manufacturers," by Ernest Van Billiard and T. Hough Jr., General Railway Signal Co., Rochester, N. Y.

"Blowers," by J. Trinks, Pittsburgh.

"Precipitation of Dust in Foundries," by H. D. Egbut, Research Corp., New York.

"Pyrometers and Their Application to Core Ovens," by J. P. Goheen, Brown Instrument Co., Philadelphia.

"Cast Iron in Service Projectiles and Trench Warfare," by Major Edgar Allen Custer, Pittsburgh district ordnance department, Pittsburgh.

"Moving picture film on the "Manufacture and Use of Hand Grenades," by Major Frank B. Gilbreth, Providence, R. I.

"A Rapid Method for the Determination of Graphitic Carbon," by Frank H. Kingdon, metallurgist, Sullivan Machinery Co., Claremont, N. J.

"Cores in the Foundry," by Walter F. Prince, Elizabeth, N. J.

Malleable Iron Foundry Practice

"Some Features of Malleable Iron Practice," by J. G. Garrard, Northwestern Malleable Iron Co., Milwaukee.

"Soundness," by Enrique Touceda, Albany, N. Y.

"Annealing Malleable Iron," by H. E. Diller, General Electric Co., Erie, Pa.

"Use of Malleable Castings," by H. A. Schwartz, National Malleable Castings Co., Indianapolis.

"White Rim or Picture Frame Fractures," by J. B. Deisher, T. H. Symington Co., Rochester, N. Y.

"Advantages of Malleable Iron Versus Steel for Agricultural Castings," by W. A. Forbes, Rockford Malleable Iron Co., Rockford, Ill.

"The Symington Core Department," by Donald S. Barrows, T. H. Symmington Co., Rochester, N. Y.

Accident Prevention Conference

"The Cause and Prevention of Industrial Accidents," to be shown by moving pictures and illustrating accidents as reported to the Industrial commission of Ohio.

"Accident Prevention is Good Business," by Hon. Fred M. Wilcox, vice president, Wisconsin industrial commission.

"What the State Can Do to Prevent Accidents," by Hon. Thomas J. Duffy, chairman, Industrial commission of Ohio.

"What the Buckeye Steel Castings Co. has Accomplished in Accident Prevention," by Fred G. Bennett, safety director, Buckeye Steel Castings Co., Columbus, O.

"The Importance of Organization in Accident Prevention," by C. W. Price, field secretary, National safety council, Chicago.

"The Vital Necessity of Conserving Man Power During the War," by Victor T. Noonan, safety director, Industrial commission of Ohio, Columbus, O.

"What Shall be Done with the Crippled Soldier," by W. A. Janssen, vice president, Canadian Steel Foundries, Montreal, Canada.

Steel Foundry Practice

"Ordnance Steel for the Army and Navy," by John Howe Hall, Taylor Wharton Iron & Steel Co., High Bridge, N. J.

"Operating an Electric Furnace for the Production of Ordnance Castings," by W. E. Moore, Union Bank building, Pittsburgh.

"Steel Foundry Practice in the Far West," by J. D. Fenstermacher, Columbia Steel Co., San Francisco.

"Acid Versus Basic Lining for Electric Furnaces," by F. J. Ryan, Electric Furnace Construction Co., Philadelphia.

An interesting report on the heat treatment of steels Nos. 2 and 3, specified by the ordnance department also will be submitted. This will be followed by a topical discussion of the manufacture of steel for ordnance purposes by foundrymen who have had a wide experience in this work.

Metals Division Program

The program of the Institute of Metals Division of the American Institute of Mining Engineers is replete with practical topics of interest to the brass foundryman. One feature of this gathering will be the discussion of the conservation of tin and representatives of various industries using tin in manufacture will contribute to this symposium. The program of the Institute of Metals Division follows:

Tuesday Morning, Oct. 8

"The Metallography of Tungsten," by Zay Jeffries.

"The Constitution of the Tin Bronzes," by S. L. Hoyt.

"Notes on Babbitt and Babbitted Bearings," by Jesse L. Jones.

"Oxygen and Sulphur in the Melting of Copper Cathodes," by S. Skowronski.

"The Relation of Sulphur to the Overpoling of Copper," by S. Skowronski, with discussion by Philip L. Gill.

Wednesday Morning, Oct. 9

Symposium on "The Conservation of Tin." This topic will be discussed by the following:

G. W. Thompson, National Lead Co.

G. H. Clamer, Ajax Metal Co., Philadelphia.

C. M. Waring, Pennsylvania Railroad Co.

M. L. Lissberger, Mark Lissberger & Son, Inc., Long Island City, N. Y.

D. M. Buck, American Sheet & Tin Plate Co., Pittsburgh.

W. M. Corse, Buffalo.

G. K. Burgess and Mr. Woodward, United States bureau of standards, Washington, D. C.

M. L. Dizer, war industries board, Washington, D. C.

A representative of the Niles, Bement, Pond Co., New York.

A representative of the bureau of steam engineering, United States navy department, Washington, D. C.

Wednesday Afternoon, Oct. 9

"The Volatility of the Constituents of Brass," by John Johnston.

"Notes on the Metallography of Aluminum," by P. D. Merica and J. R. Freeman Jr.

"The Effect of Impurities on the Hardness of Cast Zinc or Spelter," by G. C. Stone.

"Dental Alloys," by Dr. Arthur W. Gray.

"Electrolytic Zinc," by C. A. Hansen.

"The Condensation of Zinc From Its Vapor," by C. H. Fulton.

Thursday Morning, Oct. 10

"Notes on Non-Metallic Inclusions in Bronzes and Brasses," by G. F. Comstock.

"Nichrome Castings," by Arlington Bengal.

"Fusible Plug Manufacture," by G. K. Burgess and L. J. Gurevich.

"Application of the Spectroscope to the Chemical Determination of Lead in Copper," by Messrs. Hill and Lucke.

"Radium," by Richard B. Moore.

Iron and Steel to be Discussed

The first session of the Iron and Steel Section of the American Institute of Mining Engineers will be devoted to the consideration of papers on iron and steel. This will include the consideration of iron ores, ferro-alloys, silica brick and the manufacture of steel. Another meeting will consider coal and coke. The program tentatively outlined follows:

SESSION ON IRON AND STEEL

Tuesday Morning, Oct. 8

"The Limonite Deposits of Mayaguez Mesa, Porto Rico," by C. R. Fettke and Bela Hubbard.

"The Manufacture of Ferro-Alloys in the Electric Furnace," by R. M. Keeney.

"The Manufacture of Silica Brick," by H. Le Chatelier and B. Bogitch.

"Notes on Some Iron Ore Resources of the World."

"Recent Geologic Developments on the Mesabi Iron Range," discussion by Anson A. Betts and J. F. Wolff.

"A Volute Ageing Break," by Henry M. Howe.

Moving Pictures of the Triplex Steel Process.

SESSION ON COAL AND COKE

Wednesday Morning, Oct. 9

"The Byproduct Coke Oven and Its Products," by W. H. Blauvelt.

"The Use of Coal in Pulverized Form," by H. R. Collins.

"Carbocoal," by C. T. Malcolmson.

"Low-Tempered Distillation of Illinois and Indiana Coals," by G. W. Traer.

"Price Fixing of Bituminous Coal by the United States Fuel Administration," by R. V. Norris and others.

MISCELLANEOUS SUBJECTS

Wednesday Afternoon, Oct. 9

Moving pictures showing the construction of concrete ships.

Moving pictures showing the civil re-establishment of crippled soldiers in Canada.

The Exhibition

The exhibition of all kinds of labor-saving equipment, to be held in the Milwaukee auditorium, both in size and number of individual exhibits, probably will eclipse anything of its kind ever held. Machinery hall will be converted into a foundry and machine shop, since practically all of the equipment to be displayed in this section of the Milwaukee auditorium will be operated. Many new devices will be shown, which have been designed and built to facilitate the production of materials for the winning of the war. Exhibits will be made by the following manufacturers:

Abell-Howe Co., Chicago.
Abrasive Co., Philadelphia.
Allis-Chalmers Mfg. Co., Milwaukee.
American Gum Products Co., New York.
American Foundry Equipment Co., Cleveland.
American Kron Scale Co., New York.
E. C. Atkins & Co., Indianapolis.
Arcade Mfg. Co., Freeport, Ill.
Asbury Graphite Mills, Asbury, N. J.
Austin Co., Cleveland.
Ayer Lord & Tie Co., Chicago.
Badger-Packard Machinery Co., Milwaukee.
Barrett Co., Chicago.
Beaudry & Co., Boston.
Berkshire Mfg. Co., Cleveland.
S. Birkenstein & Sons, Chicago.
G. S. Blodgett Co., Burlington, Vt.
Blystone Mfg. Co., Cambridge Springs, Pa.
Brass World Publishing Co., New York.
Bristol Machine Tool Co., Bristol, Conn.
Brown Specialty Machinery Co., Chicago.
Buckeye Products Co., Cincinnati.
Bullard Machine Tool Co., Bridgeport, Conn.
Carborundum Co., Niagara Falls, N. Y.
Central Electric Co., Chicago.
Champion Foundry & Machine Co., Chicago.
Frank D. Chase, Chicago.
Chard Lathe Co., New Castle, Ind.
Charles J. Clark, Chicago.
Cincinnati Pulley Machinery Co., Cincinnati.
Cleveland Osborn Mfg. Co., Cleveland.
Cleveland Pneumatic Tool Co., Cleveland.
Clipper Belt Lacer Co., Grand Rapids, Mich.
Thomas E. Coale Lumber Co., Philadelphia.
Combined Supply & Equipment Co., Buffalo.
Corn Products Refining Co., Chicago.
Daily Iron Trade and Metal Market Report, Cleveland.
Dale-Brewster Machinery Co., Chicago.
Davenport Machine & Foundry Co., Davenport, Iowa.
Davis-Bournonville Co., Chicago.
Dayton Molding Machine Co., Dayton, O.
Deister Concentrator Co., Ft. Wayne, Ind.
Detroit Drill Co., Detroit.
Detroit Steel Products Co., Detroit.
Dings Magnetic Separator Co., Milwaukee.
Joseph Dixon Crucible Co., Chicago.
R. E. Ellis Engineering Co., Chicago.
Erwin Mfg. Co., Milwaukee.
Federal Foundry Supply Co., Cleveland.
Federal Machinery Sales Co., Chicago.
Foreign Crucibles Co., New York.
THE FOUNDRY, Cleveland.
Foundry Appliance Co., Newark, N. J.
Foundry Equipment Co., Cleveland.
Foundrymen's Supply Co., Milwaukee.
Warren F. Fraser Co., Westboro, Mass.
Garden City Sand Co., Chicago.
General Electric Co., Schenectady, N. Y.
General Steel Co., Milwaukee.
Gooley and Edlund, Cortland, N. Y.
Gordon Sand Co., Conneaut, O.
Great Western Mfg. Co., Leavenworth, Kans.
Greaves-Klusman Tool Co., Cincinnati.
Grimes Molding Machine Co., Detroit.
Hauck Mfg. Co., Brooklyn, N. Y.
Hausfeld Co., Harrison, O.
Hayward Co., New York.
Henry and Wright Mfg. Co., Hartford, Conn.
Herman Pneumatic Machine Co., Pittsburgh.
Hoevel Mfg. Corp., New York.
Holcomb Safety Garment Co., Chicago.
Holland Core Oil Co., Chicago.
Hyatt Roller Bearing Co., New York.
Imperial Brass Mfg. Co., Chicago.
Industrial Electric Furnace Co., Chicago.
International Molding Machine Co., Chicago.
The Iron Age, New York.
The Iron Trade Review, Cleveland.
Jennison-Wright Co., Toledo, O.
Chas. Jurack Pattern Works, Milwaukee.
C. C. Kawin Co., Chicago.
Kearney and Trecker Co., Milwaukee.
Spencer Kellogg & Sons, Buffalo.
Kempsmith Mfg. Co., Milwaukee.
Julius King Optical Co., Chicago.
Laclede-Christy Clay Products Co., St. Louis.
H. M. Lane Co., Detroit.
Loewenthal Co., Chicago.
Lees Bradner Co., Cleveland.
David Lupton's Sons Co., Philadelphia.
Marshall & Huschart Machinery Co., Chicago.
McCrosky Reamer Co., Meadville, Pa.
McLain's System, Milwaukee.
McLain Carter Furnace Co., Milwaukee.
Mueller Machine Tool Co., Cincinnati.
Maclean Publishing Co., Toronto, Ont.
Macleod Co., Cincinnati.
Magnetic Mfg. Co., Milwaukee.
Mahr Mfg. Co., Minneapolis.
Marden, Orth & Hastings Corp., New York.
Metal Industry, New York.
Metal and Thermit Corp., New York.
Modern Tool Co., Erie, Pa.
Monarch Engineering & Mfg. Co., Baltimore.
Monroe Calculating Machine Co., New York.
Mumford Molding Machine Co., Chicago.
Napier Saw Works, Springfield, Mass.
National Engineering Co., Chicago.
New Chicago Crucible Co., Chicago.
Wm. H. Nicholls Co., Brooklyn, N. Y.
Norma Co. of America, New York.
Norton Co., Worcester, Mass.
Oakley Machine Tool Co., Cincinnati.
S. Obermayer Co., Chicago.
Oesterlein Machine Co., Cincinnati.
Ohio Machine Tool Co., Kenton, O.
Oliver Machinery Co., Grand Rapids, Mich.
Oxweld Acetylene Co., Chicago.
Pangborn Corp., Hagerstown, Md.
Pawling & Harnischfeger Co., Milwaukee.
Peerless Machine Co., Racine, Wis.
Peck Iron & Steel Works, Kalamazoo, Mich.
Penton Publishing Co., Cleveland.
George F. Pettinos, Philadelphia.
Phoenix Mfg. Co., Eau Claire, Wis.
Pickands, Brown & Co., Chicago.
Pittsburgh Furnace Co., Milwaukee.
Portage Silica Co., Youngstown, O.
Henry E. Pridmore, Chicago.
Progressive Metal & Refining Co., Milwaukee
Quigley Furnace Specialties Co., New York
Racine Tool & Machine Co., Racine, Wis.
Railway Mechanical Engineer, Chicago.
Richards-Wilcox Mfg. Co., Aurora, Ill.
Rivett Lathe & Grinder Co., Boston.
Robeson Process Co., New York.
Rogers Brown & Co., Cincinnati.
Sand Mixing Machine Co., New York.
Schroeter Engineering Co., Chicago.
Shepard Electric Crane & Hoist Co., Montour Falls, N. Y.
Simonds Mfg. Co., Fitchburg, Mass.
W. W. Sly Mfg. Co., Cleveland.
R. P. Smith & Sons Co., Chicago.
Werner G. Smith Co., Cleveland.
Southworth Machine Tool Co., Portland, Me.
Standard Optical Co., Geneva, N. Y.
The Standard Sand & Machine Co., Cleveland.
Sterling Wheelbarrow Co., Milwaukee.
Frederic B. Stevens, Detroit.
W. F. Stodder, Syracuse, N. Y.
Strong, Kennard & Nutt Co., Cleveland.
Sullivan Machinery Co., Chicago.
Swan & Finch Co., Chicago.
Thomas Elevator Co., Chicago.
Torchweld Equipment Co., Chicago.
United Compound Co., Buffalo.
United States Graphite Co., Saginaw, Mich.
U. S. Molding Machine Co., Cleveland.
U. S. Smelting Furnace Co., Belleville, Ill.
United States Silica Co., Chicago.
Wadsworth Core Machine & Equipment Co., Akron, O.
J. D. Wallace & Co., Chicago.
Warner & Swasey Co., Cleveland.
Western Electric Co., New York.
F. H. Wheeler Mfg. Co., Chicago.
Whiting Foundry Equipment Co., Harvey, Ill.
E. J. Woodison Co., Detroit.
Young Bros. Co., Detroit.

Additional McLain-Carter Furnaces to be Installed

The McLain-Carter Furnace Co., Goldsmith building, Milwaukee, will install a 5-ton open-hearth furnace in the plant of the Malleable Iron Fittings Co., Branford, Conn., which will be ready for operation about Oct. 1. The National Steel Products Co., Bessemer, Ala., also will install a 5-ton McLain-Carter oil-fired open-hearth furnace which will melt steel about Oct. 15. The steel from both of these furnaces will be used in the manufacture of light or medium castings.

Install New Tinning Plants

The New Standard Hardware Works, Inc., Mount Joy, Pa., is installing a plant for the hot tinning of steel stampings for the Buhl Stamping Co., Detroit. Another installation, including the unit system and process, has been contracted for by the National Enameling & Stamping Co. for installation at its Milwaukee plant. This is a hot tinning unit for tinning steel stampings.

A Swiss inventor proposes to construct airplane supports, plates and stays by making them of hollow iron or steel shapes, and filling them with metallic calcium introduced while molten. The calcium is cast into the hollow shapes and the latter are then hermetically sealed. Compared with nickel-chrome steel a member so constructed, and having the same strength, has a weight of only 41.56 per cent of that of the steel.

THE FOUNDRY

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Semisteel Shell Program

Since the beginning of the war Germany has utilized its gray iron foundries to maintain its shell supply and following the battle of the Marne, when France was hard pressed for projectiles, cast semisteel was resorted to for the purpose of replenishing depleted steel shell stocks. England was next to add semisteel projectiles to the list of ordnance materials, and finally, after being at war a year and a half, we have concluded to profit by the experience of the nations that have been at war for more than four years. Early in 1916 the ordnance department of the army was furnished with all of the details of semisteel shell manufacture as practiced in France. Immediately after war was declared by the United States the American Foundrymen's association made an effort to obtain government recognition for a commission to be sent to France and England for the purpose of making a study of semisteel shell production as well as other cast war materials. Government recognition for this commission was refused and in passing upon the purpose of its mission, the ordnance department could see no need for the use of semisteel or cast shells by the army in view of our plentiful supply of steel. In the early days of our preparations for the prosecution of the war it did not seem as if it would be possible to tax the steel-producing capacity of the country to carry the conflict to a successful conclusion. However, the program expanded in geometrical proportions, until today our war needs exceed our steel supply. Largely for this reason the government is turning to the foundries and cast semisteel for relief. Contracts for approximately 1,000,000 projectiles already have been placed with foundries and orders for six or seven million additional will be given to casting plants in the near future. Tests of experimental shells prove that our foundrymen are equal to the emergency. Reports from the Aberdeen proving grounds covering firing tests of these cast projectiles not only are encouraging, but indicate that they meet all requirements. And with one exception, the foundrymen who made these projectiles had no previous experience in this line of work. However, greater progress would have been made if details of the English and French methods of production could have been available. A comprehensive report of the French process has been translated by the ordnance department. This will prove valuable to foundrymen undertaking this shell work. However, French practice will have to be modified to meet American conditions. Our methods of operation and those that are pursued in France differ widely. We will be compelled to develop a process adapted to our conditions. Since a large number of foundries will be asked to do this shell work, it would seem a logical course of procedure to develop a practice from the experience of those now engaged in this work that could be recommended to others. To permit each foundryman to do his own experimenting would entail a great loss of valuable time and would involve a needless expenditure of money. For at least seven months the needs of the army for cast shells has been known to the ordnance department. Much time was consumed in the preparation of specifications and in experimental work and there will be still further delay if each foundry that receives contracts for this work is compelled to evolve its own practice. For this reason a recommended standard process should be devised, which will be certain to expedite the production of the millions of semisteel shells required.

COMINGS AND GOINGS OF FOUNDRYMEN

E. B. Keller has been elected treasurer of the Lansdale Foundry Co., Lansdale, Pa.

C. Marsh Stewart, general superintendent, Independent Harvester Co., Plano, Ill., has accepted an appointment to an officers' training camp.

L. R. Boyer has resigned from the United States bureau of standards to become associated with E. & T. Fairbanks & Co., scale manufacturers.

C. S. Parsons of the Mines Branch, Ottawa, Ont., resigned recently to become superintendent of the Joseph Dixon Crucible Co.'s graphite mill and mine at Graphite, N. Y.

Henry Cave has been appointed production manager of the SKF Ball Bearing Co., Hartford, Conn. He was until recently, director of research for the Davis-Bournonville Co., Jersey City, N. J.

A. F. Kempe, assistant to the vice president of the Matlack Coal & Iron Corp., 52 Vanderbilt avenue, New York, now is studying naval aviation at the Massachusetts Institute of Technology, Boston.

A. G. Delany, salesman for the American Brake Shoe & Foundry Co., with headquarters at Chicago, has been made manager at Minneapolis, in charge of sales in the northwest. He has been connected with the Chicago office since 1911.

E. W. Beach, president of the Manufacturers Foundry Co., Waterbury, Conn., and associated with the Motors and Accessory Manufacturers' association, has been appointed to the inspection division of the bureau of aircraft production.

Howard Sharpe, Plainville, Conn., became production manager for the Martin-Rockwell Corp., New Haven, Conn., upon his recent resignation from the Russell & Erwin Mfg. Co., New Britain, Conn., after a service of 18 years.

A. H. Head has resigned as superintendent of Deere & Co., Moline, Ill., and has entered the United States aviation service. His position is being filled by Carl Gamble, chief of production and Theo. Brown, head of ways and means.

E. P. Dillon, manager of the power division of the New York office of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has resigned to become general manager of the Research Corp. of New York. Mr. Dillon was affiliated with the Westinghouse Co. for nine years and in 1917 was transferred to the New York office.

F. A. Mansfield, formerly with the export and industrial departments of the Westinghouse Electric & Mfg. Co., East Pittsburgh, Pa., has resigned to become manager of the Pittsburgh office of the Mechanical Appliances Co., manufacturer of motors and generators.

Arthur W. Berresford, vice president and general manager of the Cutler-Hammer Mfg. Co., Milwaukee, has been selected by employers of that city as their representative on the local community war labor board advisory to the national employment service committee.

Paul Ramp, until recently affiliated with the Moline Plow Co., Moline, Ill., and who was later associated with Deere & Co., of that city, in an advisory capacity, has entered the organization of the Campbell, Wyant & Cannon Foundry Co., Muskegon, Mich.

The Chicago Pneumatic Tool Co., Chicago, has appointed C. W. Cross as special representative for the sale of pneumatic tools to railroads, to succeed L. C. Sprague, who has been promoted to the position of district manager of sales for the company at New York.

Clarence Lundblad who was associated for several years in the capacity of foundry foreman with Foster, Merriam & Co. and the Bradley-Hubbard Mfg. Co., Meriden, Conn., has accepted a similar position with the Marshall Castings Co., South Haven, Mich. This company specializes in automobile and truck engine manifolds.

W. M. Corse has resigned as general manager of the Titanium Bronze Co., Niagara Falls, N. Y. On Oct. 1 he will become affiliated with the Ohio Brass Co., Mansfield, O. For many years Mr. Corse was secretary-treasurer of the American Institute of Metals, now the Institute of Metals division of the American Institute of Mining Engineers. Last year he was elected president of this organization.

William A. Rosenberger, who has had a wide experience in the design and installation of sand-blast equipment and who for several years was affiliated with the Pangborn Corp., Hagerstown, Md., in the capacity of mechanical engineer, has established an office at 132 Nassau street, New York. Mr. Rosenberger will advise prospective users of sand-blast machinery regarding the best equipment for their particular work and he will remodel old installations to meet new conditions, etc.

Whiting Sells Only Calumet Foundry

In view of the recent sale of a foundry by the Whiting Foundry Equipment Co., Harvey, Ill., it has been rumored that the foundry equipment business of this company has been sold. This, however, is not the case. A number of years ago the Whiting Foundry Equipment Co. purchased the plant and business of the Calumet Foundry Equipment Co. at Harvey, Ill., and recently the foundry operated in connection with this plant was sold. This casting shop is located approximately three miles from the main works of the Whiting Foundry Equipment Co.

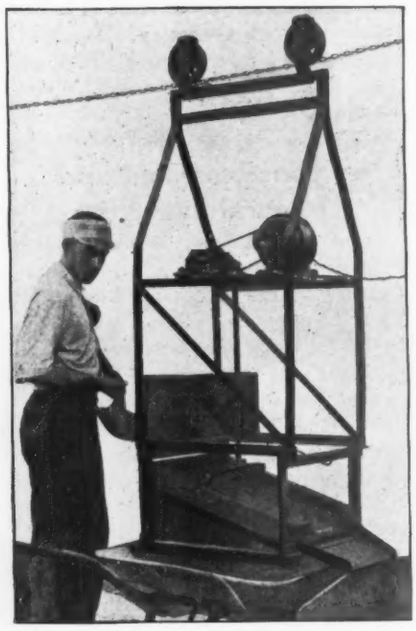
New Correspondence Course in Industrial Engineering

A correspondence course in industrial engineering is being offered by the Woods Industrial Engineering Co., Bridgeport, Conn., which embraces subjects divided into the following nine groups: Organization control; inventory control; production control; labor control; depreciation control; overhead control; cost accounting; commercial accounting and controling accounts. These groups are subdivided into lectures and lessons which will be given as nearly as possible in the sequence in which the work would be applied in practice. This highly specialized course is given for the purpose of developing the student into a master of manufacture either as an engineer or as an executive. In addition, it is proposed to lay out lecture zones in such localities as will permit of bringing together at least 20 students to whom Clinton E. Woods will deliver additional personal lectures about every 90 days, copies of which will be sent to all the others who are taking this course.

The Industrial Electric Furnace Co., Chicago, builder of the Snyder furnaces, is installing a 5-ton unit in the plant of the Zimmerman Steel Co., Bettendorf, Ia. This furnace is of the three-phase type and is designed for acid operation.

Portable Riddle for Screening Molding Sand

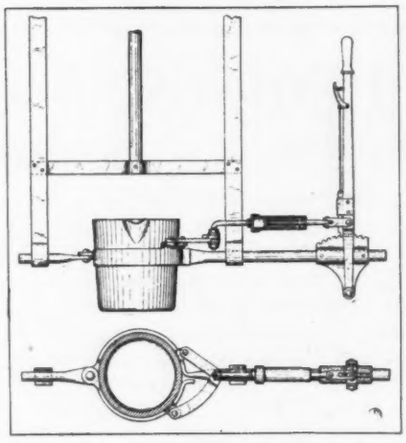
An electrically-driven portable riddle for screening molding sand is being built for the foundry trade by the Maroa Mfg. Co., Maroa, Ill. As indicated in the accompanying illustration, the riddle may be suspended from a cable, rod, chain or any suitable overhead track, and inasmuch as it weighs only 115 pounds, it may be transferred easily from point to point in the shop, wherever it is found desirable to screen the sand with a minimum amount of subsequent handling. The riddle may be suspended over a mold if desired and the sand may be sifted directly onto the pattern in the flask. The electric motor imparts to the screen a vibratory motion which sifts the sand thoroughly. It will be noted that the riddle is provided with a small hopper which holds several shovelfuls of sand and the speed at which it is directed onto the riddle can be controlled by



ELECTRICALLY-OPERATED PORTABLE FOUNDRY RIDDLE

a slide valve in the hopper. Also, by means of a foot switch, the sand can be conveniently sifted directly onto the work.

The machine remains stationary while in operation, the vibratory motion of the screen imparting no movement whatever to the riddle. This is a particularly desirable feature since it permits of directing the flow of screened sand to any desired point. The riddled sand, as shown in the accompanying illustration, falls into a wheelbarrow underneath the screen and the foreign particles, pebbles, etc., are carried off by a chute extending from the front end of the screen at the lower end.



CRUCIBLE OR LADLE SHANK, WITH LEVER-OPERATED, CONTRACTING AND EXPANDING BAND

The frame of the riddle is built of steel angles and the machine has an overall height of 5 feet 6 inches, is 21 inches wide and 24 inches long. The electric current consumption is small, since the screen may be vibrated by ⅛-horsepower motor. The screen is well protected, being bound with steel straps and the wire can be removed readily by clipping the heads from several rivets. It will be noted that the motor and all operating parts for the vibration of the riddle are above the screen and away from contact with the sand.

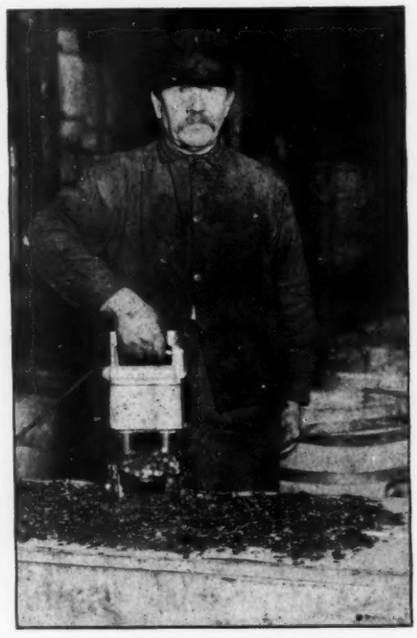
A Lever-Operated Crucible Shank

A crucible shank of a novel type, which also is adaptable to ladles for carrying iron, has been patented by Max W. Goldberg, Milwaukee. As shown in the accompanying illustration, it consists of a circular band for enclosing the crucible or ladle and means for transporting the metal container. The shank has a positive locking arrangement for retaining the ring around the crucible.

Two forms of shanks are in use for carrying ladles and crucibles in foundries, namely the rigid, one piece, circular band with extending handles welded into one piece and the hinged shank which has a split, circular band hinged at one side so that the band can be opened like a pair of tongs. The tong shank, however, is liable to possess weaknesses resulting from the method of its construction. This tendency is overcome in the Goldberg shank by attaching a pair of hinged jaws to each half of the crucible ring, which are operated by a locking lever. When the lever is moved toward the crucible or ladle, the ring is expanded so that it will pass over the top of the vessel; when the lever is pulled away from the crucible, the ring is contracted around the metal container. The lever also is used for tilting the receptacles.

Cutler-Hammer Hand Magnet Improved

For the purpose of removing ferrous particles from brass and other nonferrous scrap, the hand magnet manufactured by the Cutler-Hammer Mfg. Co., Milwaukee, may be employed satisfactorily. In the accompanying illustration the use of the hand magnet for separating iron punchings from copper punchings is demonstrated. This magnet recently has been considerably improved in construction, the magnetic coils, switch and connections now being entirely covered by two aluminum castings. The upper aluminum casting forming the yoke cover, switch cover and handle supports. The lower casting covers the coils and leaves only the soft iron poles projecting. The circuit to the magnetic coils is closed and opened by a large trigger mounted under the handle in the handle support, which operates a strong quick make-and-break switch concealed in the cover.



CUTLER-HAMMER HAND MAGNET USED FOR SEPARATING IRON

This magnet can be used to advantage in various types of industrial works including smelting and refining plants, iron and brass foundries, storage yards of metal dealers, by enamelers, electroplaters, etc. In the manufacture of spelter solder this hand magnet is employed for removing copper-coated iron and steel wire.

Easily-Operated Foundry Flask

The flask shown in the accompanying illustration was recently developed by the Diamond Clamp & Flask Co., Richmond, Ind. The wood used is seasoned cherry and maple. The flask

corners are machine-locked, dipped in glue and held under pressure until the glue is thoroughly set. To render the woodwork impervious to moisture, each flask is finished with three coats of shellac.

The latch, pin, socket and hinge are designed to permit rapidity and precision of operation while the sections are of ample dimensions to insure strength and rigidity. The latch is of the drop type and can be placed on the left or right-hand corner. The engagement is rapid, the cam on the lever drawing the flask together as it engages.

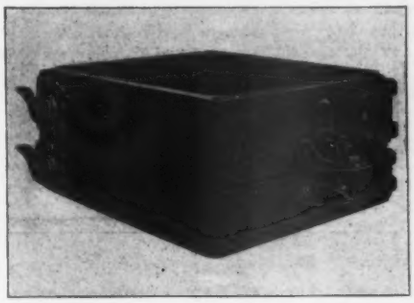
The pin and socket are designed to overcome difficulties encountered in match-plate work; or on any other job where a difficult lift is encountered. The adjustable features of the pin and socket make them adaptable to both straight and taper flasks. The bearing surface of the guide is long, the angle being 60 degrees. This, together with the ball and socket adjustment, is said to insure a perfect lift, eliminating any possible shock while disengaging the cope from the drag.

The hinge lugs have large bearing surfaces and are interlocking. They are accurately machined and fitted together which insures ease in operating the flask. All metal parts are made of malleable iron with the exception of the pins and sockets which are gray iron.

Double Pass Recuperative Furnaces Save Fuel

(Concluded from page 432)

This central chamber insures a uniform mixture of gas and air. The products of combustion pass to the recuperators



NEW TYPE OF FLASK

underneath the furnace. The recuperators are further adapted for heating ingots, and in connection with forging, or annealing furnaces. In the last 10 years, fully 2000 recuperator furnaces have been installed in various plants. Recuperator furnaces of this type are designed and built by A. Hermansen, Woolworth building, New York.

Red Brass Alloys

By Charles Vickers

In these days of high cost of nonferrous metals, brass founders are striving to reduce the amount of copper required and yet they aim to retain the color of red brass in their alloys. In nearly every issue of THE FOUNDRY, for the past two years, I have noticed some request for a cheap red brass mixture and none of the replies has ever recommended the use of less than 69 pounds of copper per 100 pounds of mixture, which is not a very cheap alloy. However, I have developed the following alloy which gives the red color desired: Scrap metal, 71 pounds; copper, 25 pounds; tin, 1 pound; lead, 1½ pounds, and zinc, 1½ pounds. First melt the scrap under fine charcoal, and this is followed by the addition of the copper, tin, lead and zinc in the order named.

It is advisable to buy heavy scrap of almost any kind since bulky scrap is nearly all red brass. Care should be exercised to eliminate yellow brass, aluminum or aluminum bronze scrap. The mixture given machines well, is close-grained and takes a fairly good polish.

New Foundry Supply House Organized

The Foundrymen's Supply Co., Milwaukee, is the successor of the C. F. Sammond Co., which in turn had succeeded the American Sales Co. Under the new management this company has taken over molding, core and other grades of sand from 21 supply points in the United States. It also handles steel ladles, chaplets, brushes, plumbagos and facings.

WHAT THE FOUNDRIES ARE DOING

Activities of the Iron, Steel and Brass Shops

The erection of an addition to the plant of the Hunter Foundry, Berkeley, Cal., has been started.

An addition, 35 x 80 feet, to the foundry of Edwin A. Moore, Reading, Pa., is being erected.

Landers, Frary & Clark, New Britain, Conn., plan the construction of an addition to its iron foundry.

Plans are being prepared for a brick and steel foundry, 30 x 81 feet, for the Rands Iron Works, Vancouver, Wash.

The John Inglis Co., Ltd., Toronto, recently rented a foundry and will operate it in conjunction with its plant on Strachan avenue.

The Williamette Brass Foundry, Portland, Oreg., recently completed plans for a new plant. The building will be 50 x 90 feet.

The Lundin Steel Castings Co., Boston, is building a brick, 60 x 100-foot addition to its foundry.

A foundry addition to the plant of the Bayley Mfg. Co., Milwaukee, is being contemplated. Plans have not been completed.

The Hercules Steel Casting Co., Milwaukee, recently let a contract for the erection of a foundry building to cost $100,000.

The Filer & Stowell Co., Milwaukee, will build a foundry, 60 x 108 feet, which will cost about $21,000.

The Flower-Stephens Mfg. Co., Detroit, is contemplating the erection of a 135 x 225-foot foundry.

The Pacific Car & Foundry Co., Portland, Oreg., is making extensive improvements to its plant.

The Milford Iron Foundry, Milford, Mass., recently let a contract for an 88 x 97-foot addition.

A small addition to the foundry of the Cathapole Boiler Works, Geneva, N. Y., is being contemplated.

The Franklin Brass Foundry Co., Battle Creek, Mich., has taken over the factory of the American Column Co.

The Allen Foundry & Machine Works Co., Lancaster, O., is contemplating the erection of an addition to its plant.

The Zimmerman Steel Co., Bettendorf, Iowa, is installing a 6-ton electric furnace of the Snyder type, which is being furnished by the Industrial Electric Furnace Co., Chicago.

The erection of a foundry is being contemplated by the Richard De Cou Co., Philadelphia.

The Chicago Hardware & Foundry Co., Chicago, is erecting a 2-story building, 40 x 200 feet, at a cost of $25,000.

The capital stock of the Pulaski Foundry Co., Pulaski, Va., has been increased from $50,000 to $100,000.

The Standard Stoker Co., Gaskell avenue, Erie, Pa., is building two additions to its foundry, each to be 35 feet square.

A brick and steel iron foundry, 41 x 343 feet, to cost $40,000, is to be erected by the Hay Foundry & Iron Works, Newark, N. J.

The new foundry department of the Litnum Bronze Co., Menomonie, Wis., which has been under construction for some time, has been completed and now is in operation.

The Doehler Die Castings Co., Toledo, O., manufacturer of hand grenades, depth bombs, parts of gas masks, etc., is contemplating the erection of a 100-foot addition to its foundry

and a 2-story, 50 x 150-foot manufacturing building.

The Standard Semi-Steel Foundry Co., Harrisonville, Mo., has purchased a 75 x 200-foot building at Clinton, Mo., and plans to remodel it into a foundry.

The Central Forge & Machine Co., Detroit, has let the general contract for the erection of a foundry, to the W. E. Wood Company.

The Mars Metal Co., 1049 Railroad avenue, Seattle, Wash., recently awarded a contract for the erection of a 1-story, 90 x 120-foot foundry.

The Haynes Stellite Co., Kokomo, Ind., is building a machine shop and foundry, 60 x 132 feet. The new plant when completed will represent an outlay of $30,000.

The Hoskins Mfg. Co., Lawton avenue, Detroit, Mich., manufacturer of pyrometers and wire products, is contemplating the erection of a foundry, 60 x 100 feet.

The Murphy Aluminum & Bronze Foundry, Amesbury, Mass., recently was incorporated with $10,000 capital, by Norman Russell, William J. Murphy and William H. Clark.

A foundry, 86 x 206 feet, is being erected by the Pittsburgh Bridge & Iron Co., Rochester, Pa., for the Bovaird & Seyfang Mfg. Co., Bradford, Pa.

The Michigan Steel Castings Co., Detroit, has awarded a contract for the erection of a 3-story, 90 x 120 foot foundry, which is to be built at an estimated cost of $65,000.

The Southwark Foundry & Machine Co., Philadelphia, builder of engines and rolling mill equipment, is building a 55 x 135-foot foundry and machine shop addition.

The National Steel Foundries, Milwaukee, has awarded a contract to the Meredith Bros Co., for the construction of an open-hearth furnace.

The contract for the erection of an addition to the plant of the Smith Bros. Foundry Co., Fredericton, N. B., has been let to J. H. Ward.

The South Haven Foundry & Machine Co., South Haven, Mich., has been incorporated with $25,000 capital, by H. E. Skinner, A. W. Harriman and S. H. Wilson.

The C. F. Braun Foundry, San Francisco, is building a brick addition which, when completed, will add about 50 per cent to its floor space.

The Wheeling Mold & Foundry Co., Wheeling, W. Va., recently equipped its Manchester works for the manufacture of large shells. New machinery is to be installed.

A contract for the erection of an addition, 20 x 60 feet, to the plant of the Bay State Foundry Co., Westfield, Mass., recently was let to George H. Stevenson.

The Matawan Steel & Iron Co., Matawan, N. J., operators of a gray iron foundry, recently changed its name to the Wickham Co., of New Jersey.

The Vulcan Mfg. Co., Seattle, Wash., is contemplating the erection of extensions to its plant, which include a foundry. The improvements will cost about $15,000.

A brick and steel, 60 x 80-foot shop addition, is being erected by the North End Foundry Co., West Allis, Wis. It is estimated the extension will cost $15,000.

The plant of the Chattanooga Car & Foundry Co., Chattanooga, Tenn., recently was acquired by the Lucey Mfg. Co., of that city. The plant is to be converted into a shop for the manufacture of well drilling machinery.

The Universal Machinery Co., Milwaukee, has awarded the contract for the structural steel for the power plant of its new foundry, to the Lakeside Bridge & Steel Co., North Milwaukee. The foundry is now well under construction. Frank E. Gray and Val. A. Siebert are architects. The project, according to an estimate, will cost about $200,000.

The Vaughan Motor Works, Portland, Oreg., is erecting a building 50 x 132 feet, to be used as an assembling plant; an addition to its foundry, 38 x 50 feet, and an addition to its blacksmith shop, 25 x 30 feet.

Plans are being prepared for the enlargement of its shops and the construction of new pattern shops and a foundry building for the Schaake Co., Ltd., Vancouver, B. C. The foundry is to be 40 x 120 feet.

An addition to the brass foundry of the Matt Cochran Co., Louisville, Ky., is being erected. The structure, when completed, will be 30 x 125 feet. Additional equipment will be installed.

An addition to the plant of the Bond Engineering Works, Ltd., Toronto, Ont., is now being erected. The company has let contracts for foundry equipment, power transmission, electrical machinery, etc.

The Carbon Steel Co., Pittsburgh, recently purchased the former Lupton foundry building for $95,000. The building, which is on a site 120 x 165 feet, is to be used as an extension to the steel company's plant.

J. H. Ward, Fredericton, N. B., has the general contract for the construction of a brick addition to the plant of the Smith Bros. Foundry Co., which is to be erected at a cost of $40,000.

Work on the erection of a foundry addition to the plant of the Metal & Thermit Corp., Jersey City, N. J., has been started. The building will be 35 x 100 feet and will cost approximately $15,000.

The Newport News Shipbuilding & Dry Dock Co. is building a new plant at Richmond, Va., to include a 160 x 600-foot foundry, machine and boiler shop, as well as other units. It is estimated the works will cost about $4,000,000.

The Standard Foundry Co., Racine, Wis., has been reorganized following the purchase of the interests of Albert and Henry Kousek, founders of the business, by Arthur R. Janes, who has been elected president and general manager of the company. Davis G. Jones has been elected vice president and E. L. Mikvicka, secretary and treasurer.

An addition to the foundry of the McCairns Foundry Co., Connellsville, Pa., is being contemplated by the officials of the company. According to present plans the addition will be 60 x 65 feet and will cost approximately $10,000.

The Old Colony Foundry Co., East Bridgewater, Mass., recently was incorporated with $100,000 capital, by Charles L. Nutter, Richard W. Nutter, Brockton, Mass., and Samuel K. Nutter. Plans of the new company have not been announced.

The Kilby Mfg. Co., Cleveland, will build a gray iron foundry on the site of its present plant. The new shop will be 55 x 220 feet and will be equipped with two cupolas. The company has been manufacturing sugar refining machinery, but intends to devote a large part of its facilities to the manufacturing of punching and shearing machines.

The General Motors Corp., Flint, Mich., has decided to erect a large tractor plant at Saginaw, Mich., the first unit of which will consist of a foundry to be built at an estimated cost of $1,000,000. Plans are now being prepared and contracts will be awarded shortly for the buildings and equipment.

The A. Gilbert & Sons Brass Foundry Co., St. Louis, is enlarging its plant by the erection of an extension to the machine shop and foundry, and a 2-story extension to its manufacturing building. The improvements will cost about $15,000. The company recently increased its capitalization from $50,000 to $100,000.

The R. M. Eddy Foundry Co., Chicago, has purchased a site on which to build a plant, 90 x 284 feet. The contract for the erection of the building has been awarded the Austin Co., Cleveland. The building will be of brick and steel construction and will cost about $100,000. The new factory will be used for the manufacture of a lathe for end-facing and grooving shells. Considerable machinery is to be bought for the new plant which is to be operated separate from the main works of the company.

NEW TRADE PUBLICATIONS

DRUM-TYPE CONTROLLERS.—A 6-page folder devoted to drum-type controllers for machine tool service has been issued by the General Electric Co., Schenectady, N. Y. The construction of these controllers is described at length and tables of capacities and dimensions are included.

DUST SYSTEMS.—A 24-page catalog issued by the Clark Dust Collecting Co., Fisher building, Chicago, illustrates and describes its dust collecting systems designed for the recovery of any solids from fumes, gases or dust-laden air. This equipment is adapted to all kinds of industrial operations where the removal of dust is a menace particularly in iron, steel and brass foundries, and other metal-working plants.

ELECTRIC GRAB BUCKET HOISTS.—The Sprague Electric Works of the General Electric Co., New York, in a 24-page bulletin illustrates and describes in detail electric grab bucket hoists for handling materials in foundries and industrial plants generally. These hoists operate on a monorail system and may be used to advantage in foundries for handling sand, coal, etc. In addition to details of construction, tables of sizes and capacities, the bulletin also contains numerous views of various applications of these grab bucket hoists.

INSULATING BRICK. — A 4-page folder has been issued by the Armstrong Cork & Insulation Co., Pittsburgh, which is devoted to insulating brick for furnaces and ovens. These bricks are adapted for use in all kinds of heating and melting furnaces and have been used to advantage for insulating malleable annealing ovens. The bulletin states that the element of time saving in heating such ovens has been demonstrated strikingly in the plant of the Link-Belt Co., Indianapolis. Seven of this company's nine annealing furnaces are insulated and to bring these up to the temperature of 1500 degrees Fahr. requires only 50.7 hours as against 66.5 hours for the furnaces that are not so insulated, a net gain of 15.8 hours per heat.